

Magnetic Field and Magnetic Forces

DPP 1.1

Motion of Charged Particle in Magnetic Field 1

Single Correct Answer Type

- A uniform electric field and a uniform magnetic field are produced, pointed in the same direction. An electron is projected with its velocity pointing in the same direction
 - The electron will turn to its right
 - The electron will turn to its left
 - The electron velocity will increase in magnitude
 - The electron velocity will decrease in magnitude
- An electron moves with speed 2×10^5 m/s along the positive x -direction in the presence of a magnetic induction $B = \hat{i} + 4\hat{j} - 3\hat{k}$ (in Tesla). The magnitude of the force experienced by the electron in Newton's is (charge on the electron = 1.6×10^{-19} C)
 - 1.18×10^{-13}
 - 1.28×10^{-13}
 - 1.6×10^{-13}
 - 1.72×10^{-13}
- A proton (mass m and charge $+e$) and an α -particle (mass $4m$ and charge $+2e$) are projected with the same kinetic energy at right angles to the uniform magnetic field. Which one of the following statements will be true?
 - The α -particle will be bent in a circular path with a small radius that for the proton
 - The radius of the path of the α -particle will be greater than that of the proton
 - The α -particle and the proton will be bent in a circular path with the same radius
 - The α -particle and the proton will go through the field in a straight line
- A proton is moving along Z -axis in a magnetic field. The magnetic field is along X -axis. The proton will experience a force along
 - X -axis
 - Y -axis
 - Z -axis
 - Negative Z -axis
- A proton of mass m and charge $+e$ is moving in a circular orbit in a magnetic field with energy 1 MeV. What should be the energy of α -particle (mass = $4m$ and charge = $+2e$), so that it can revolve in the path of same radius?
 - 1 MeV
 - 4 MeV
 - 2 MeV
 - 0.5 MeV
- A deuteron of kinetic energy 50 keV is describing a circular orbit of radius 0.5 metre in a plane perpendicular to magnetic field $\vec{B}$. The kinetic energy of the proton that describes a circular orbit of radius 0.5 metre in the same plane with the same $\vec{B}$ is
 - 25 keV
 - 50 keV
 - 200 keV
 - 100 keV
- An electron and a proton enter region of uniform magnetic field in a direction at right angles to the field with the same kinetic energy. They describe circular paths of radius r_e and r_p respectively. Then
 - $r_e = r_p$
 - $r_e < r_p$
 - $r_e > r_p$
 - r_e may be less than or greater than r_p depending on the direction of the magnetic field
- The charge on a particle Y is double the charge on particle X . These two particles X and Y after being accelerated

1.2 Magnetism and Electromagnetic Induction

through the same potential difference enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of the mass of X to that of Y is

- (a) $\left(\frac{2R_1}{R_2}\right)^2$ (b) $\left(\frac{R_1}{2R_2}\right)^2$
 (c) $\frac{R_1^2}{2R_2^2}$ (d) $\frac{2R_1}{R_2}$

9. A particle of charge q and mass m moving with a velocity v along the x -axis enters the region $x > 0$ with uniform magnetic field B along the $\hat{k}$ direction. The particle will penetrate in this region in the x -direction up to a distance d equal to

- (a) Zero (b) $\frac{mv}{qB}$
 (c) $\frac{2mv}{qB}$ (d) Infinity

10. An electron is moving along positive x -axis. To get it moving on an anticlockwise circular path in x - y plane, a magnetic field is applied

- (a) Along positive y -axis (b) Along positive z -axis
 (c) Along negative y -axis (d) Along negative z -axis

11. A particle of mass 0.6 g and having charge of 25 nC is moving horizontally with a uniform velocity 1.2×10^4 ms $^{-1}$ in a uniform magnetic field, then the value of the magnetic induction is ($g = 10$ ms $^{-2}$)

- (a) Zero (b) 10 T
 (c) 20 T (d) 200 T

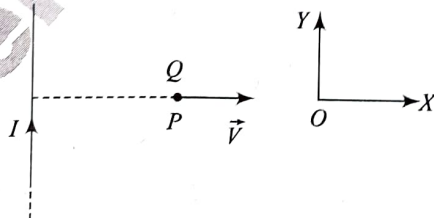
12. An electron is travelling along the x -direction. It encounters a magnetic field in the y -direction. Its subsequent motion will be

- (a) Straight line along the x -direction
 (b) A circle in the xz -plane
 (c) A circle in the yz -plane
 (d) A circle in the xy -plane

13. An electron, a proton, a deuteron and an alpha particle, each having the same speed, are in a region of constant magnetic field perpendicular to the direction of the velocities of the particles. The radius of the circular orbits of these particles are respectively R_e , R_p , R_d and R_α . It follows that

- (a) $R_e = R_p$ (b) $R_p = R_d$
 (c) $R_d = R_\alpha$ (d) $R_p = R_\alpha$

14. A very long straight wire carries a current I . At the instant when a charge $+Q$ at point P has velocity $\vec{v}$, as shown, the force on the charge is



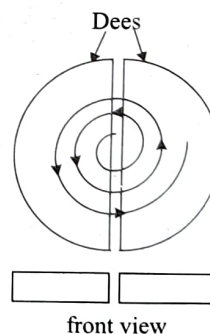
- (a) Opposite to OX (b) Along OX
 (c) Opposite to OY (d) Along OY
15. An electron (mass $= 9.1 \times 10^{-31}$ kg; charge $= 1.6 \times 10^{-19}$ C) experiences no deflection if subjected to an electric field of 3.2×10^5 V/m, and a magnetic field of 2.0×10^{-3} Wb/m ^{2} . Both the fields are normal to the path of electron and to each other. If the electric field is removed, then the electron will revolve in an orbit of radius
- (a) 45 m (b) 4.5 m
 (c) 0.45 m (d) 0.045 m

Comprehension Type

A cyclotron is a device for accelerating ions and charged particles. It was developed by Lawrence in 1932.

The heart of the apparatus consists of a split metal pillbox. Figure shows top and front views of the halves called dees. A rapidly oscillating potential difference is applied between the Dees. This produces an oscillating electric field in the gap between the Dees, the region inside each Dee being essentially free of electric field. The Dees are enclosed in an evacuated container, and the entire unit is placed in a uniform magnetic field B whose direction is normal to the plane of Dees. A charged particle of mass ' m ' and charge ' q ' in the gap between the Dees is accelerated by the electric field towards one of them. Inside the Dees, it moves with constant speed in a semi-circle.

The period of uniform circular motion is $T = \frac{2\pi m}{qB}$ and is independent of speed. If the time period of the oscillating electric field is equal to this time, then the charged particle will be accelerated again and again.



Answer the following questions (consider the mass of particles remains constant during motion):

16. A cyclotron is accelerating deuterons having mass $= 2 \times 1.6 \times 10^{-27}$ kg and charge $+e$. If $B = 2$ T, then the required angular frequency of oscillating electric field is:
 (a) 10^8 radian/sec (b) 10^7 radian/sec
 (c) 10^{10} radian/sec (d) 10^9 radian/sec
17. The maximum radius of the Dees required if deuteron is to acquire 100 MeV of energy in the above question is:
 (a) 0.5 m (b) 1 m
 (c) 2 m (d) 4 m

18. If the deuterons are to acquire 100 MeV of kinetic energy and the difference of potential across the gap is 20 kV, then number of passes through electric field will be:
 (a) 200 (b) 2000
 (c) 500 (d) 5000
19. A cyclotron has been adjusted to accelerate deuterons. It is now to be adjusted to accelerate other particles, for this the following changes may be made:
 (a) In order to keep the frequency of oscillating electric field same, the magnetic field is halved for proton
 (b) If the magnetic field remains unchanged, the oscillation frequency of electric field should be halved for α particle.
 (c) If the magnetic field remains unchanged, the oscillation frequency of electric field should be doubled for proton.
 (d) If the frequency of oscillating electric field is kept same, the magnetic field should be kept same for α particle.
 (a) a, b and c (b) a, b and d
 (c) a, c and d (d) b, c and d
20. In a cyclotron resonance experiment, if we assume that maximum radius attained by any charged particle is equal to radius of dees, then minimum kinetic energy gained by the particles will be:
 (a) alpha particle (b) proton
 (c) deuteron (d) same for all

Answers Key

Single Correct Answer Type

1. (d) 2. (c) 3. (c) 4. (b) 5. (a)
 6. (d) 7. (b) 8. (c) 9. (b) 10. (b)
 11. (c) 12. (b) 13. (c) 14. (d) 15. (c)

Comprehension Type

16. (a) 17. (b) 18. (d) 19. (c) 20. (c)

DPP 1.2

Motion of Charged Particle in Magnetic Field 2

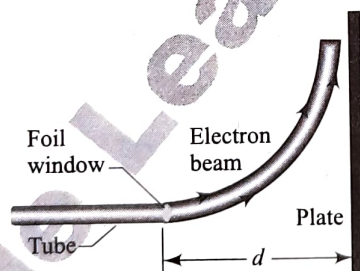
Subjective Type

1. A proton of charge $+e$ and mass m enters a uniform magnetic field $\vec{B} = B\hat{i}$ with an initial velocity $\vec{v} = v_{0x}\hat{i} + v_{0y}\hat{j}$. Find an expression in unit-vector notation for its velocity at any later time t .
2. An electron with kinetic energy 2.5 keV moving along the positive direction of an x -axis enters a region in which a uniform electric field of magnitude 10 kV/m is in the negative direction of the y -axis. A uniform magnetic field $\vec{B}$ is to be set up to keep the electron moving along the x -axis, and the direction $\vec{B}$ of is to be chosen to minimize the required magnitude of $\vec{B}$. In unit-vector notation, what $\vec{B}$ should be set up?
3. A beam of electrons whose kinetic energy is K emerges from a thin-foil "window" at the end of an accelerator tube. A metal plate at distance d from this window is perpendicular to the direction of the emerging beam. (a) Show that we can prevent the beam from hitting the plate if we apply a uniform magnetic field such that

$$B \geq \sqrt{\frac{2mK}{e^2 d^2}},$$

in which m and e are the electron mass and charge.

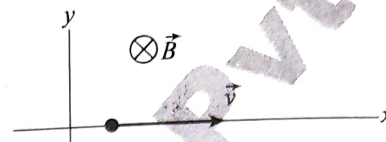
(b) How should $\vec{B}$ be oriented?



4. A particle with charge 2.0 C moves through a uniform magnetic field. At one instant the velocity of the particle is $(2.0\hat{i} + 4.0\hat{j} + 6.0\hat{k})$ m/s and the magnetic force on the particle is $(4.0\hat{i} - 20\hat{j} + 12\hat{k})$ N.

The x and y components of the magnetic field are equal. What is $\vec{B}$?

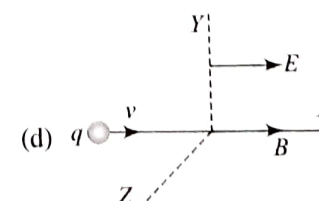
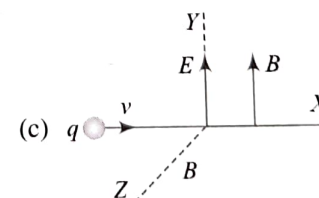
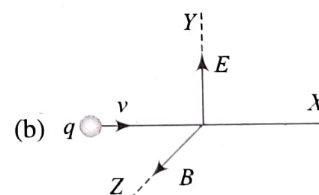
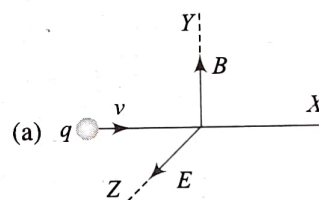
5. In the below figure, an electron moves at speed $v = 100$ m/s along an x -axis through uniform electric and magnetic fields. The magnetic field is directed into the page and has magnitude 5.00 T. In unit-vector notation, what is the electric field?



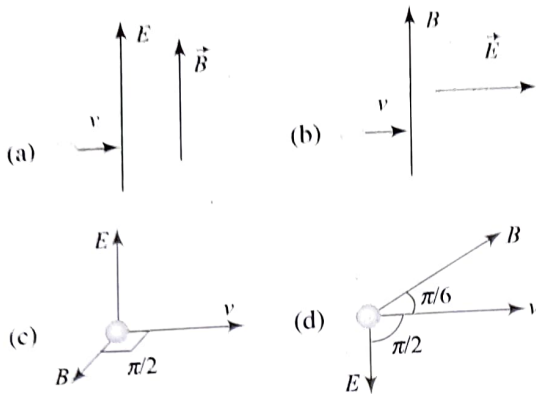
6. A particle of mass 6.0 g moves at 4.0 km/s in an xy plane, in a region with a uniform magnetic field given by $5.0\hat{i}$ mT. At one instant, when the particle's velocity is directed 37° counterclockwise from the positive direction of the x -axis, the magnetic force on the particle is $0.45\hat{k}$ N. What is the particle's charge?

Single Correct Answer Type

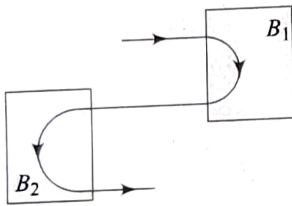
7. A particle of charge q and mass m is moving along the x -axis with a velocity v and enters a region of electric field E and magnetic field B as shown in figure below for which figure the net force on the charge may be zero



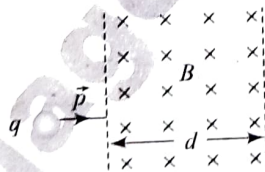
8. A uniform magnetic field B and a uniform electric field E act in a common region. An electron is entering this region of space. The correct arrangement for it to escape undeviated is



9. Following figure shows the path of an electron that passes through two regions containing uniform magnetic fields of magnitudes B_1 and B_2 . Its path in each region is a half circle, choose the correct option



- (a) B_1 is into the page and it is stronger than B_2
 (b) B_1 is into the page and it is weaker than B_2
 (c) B_1 is out of the page and it is weaker than B_2
 (d) B_1 is out of the page and it is stronger than B_2
10. A particle with charge q , moving with a momentum p , enters a uniform magnetic field normally. The magnetic field has magnitude B and is confined to a region of width d , where $d < \frac{p}{Bq}$. The particle is deflected by an angle θ in crossing the field



- (a) $\sin \theta = \frac{Bqd}{p}$ (b) $\sin \theta = \frac{p}{Bqd}$
 (c) $\sin \theta = \frac{Bp}{qd}$ (d) $\sin \theta = \frac{pd}{Bq}$

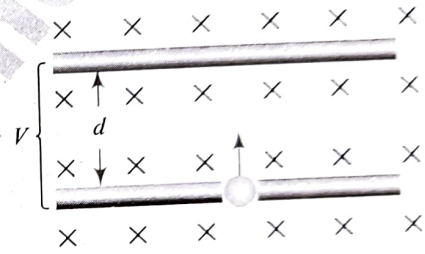
11. A particle having a charge of $10.0 \mu\text{C}$ and mass $1 \mu\text{g}$ moves in a circle of radius 10 cm under the influence of a

magnetic field of induction 0.1 T . When the particle is at a point P , a uniform electric field is switched on so that the particle starts moving along the tangent with a uniform velocity. The electric field is



- (a) 0.1 V/m (b) 1.0 V/m
 (c) 10.0 V/m (d) 100 V/m

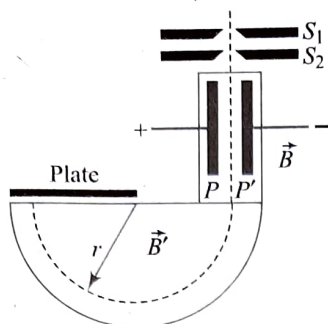
12. In the below figure, an electron of mass m , charge $-e$, and low (negligible) speed enters the region between two plates of potential difference V and plate separation d , initially headed directly toward the top plate. A uniform magnetic field of magnitude B is normal to the plane of the figure. Find the minimum value of B such that the electron will not strike the top plate.



- (a) $\sqrt{\frac{2mV}{ed^2}}$ (b) $\sqrt{\frac{mV}{2ed^2}}$
 (c) $\sqrt{\frac{mV}{ed^2}}$ (d) $2\sqrt{\frac{mV}{ed^2}}$

13. Bainbridge's mass spectrometer separates ions having the same velocity. The ions, after entering through slits S_1 and S_2 , pass through a velocity selector composed of an electric field produced by the charged plates P and P' and a magnetic field $\vec{B}$ perpendicular to the electric field and the ion path. The ions that then pass undeviated through the crossed $\vec{E}$ and $\vec{B}$ fields enter into a region where a second magnetic field $\vec{B}$ exists, where they are made to follow circular paths. A photographic plate (or a modern detector) registers their arrival. If r is the radius of the circular orbit, then specific charge $\frac{q}{m}$ of ion is

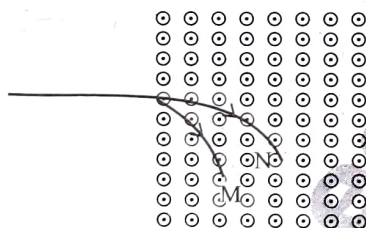
- (a) $\frac{E}{rBB'}$ (b) $\frac{2E}{rBB'}$
 (c) $\frac{3E}{2rBB'}$ (d) $\frac{2E}{3rBB'}$



14. An electron moves through a uniform magnetic field given by $\vec{B} = B_x \hat{i} + (3.0 B_x) \hat{j}$. At a particular instant, the electron has velocity $\vec{v} = (2.0 \hat{i} + 4.0 \hat{j})$ m/s and the magnetic force acting on it is $(6.4 \times 10^{-19} \text{ N}) \hat{k}$. The value of B_x (in T) will be
- (a) -3.0 (b) 3.0
(c) 2.0 (d) -2.0

Multiple Correct Answers Type

15. A charged particle would continue to move with a constant velocity in a region wherein,
- (a) $\vec{E} = 0, \vec{B} \neq 0$ (b) $\vec{E} \neq 0, \vec{B} \neq 0$
(c) $\vec{E} \neq 0, \vec{B} = 0$ (d) $\vec{E} = 0, \vec{B} = 0$
16. Two charged particles M and N enter a space of uniform magnetic field, with velocities perpendicular to the magnetic field. The paths are as shown in the figure. The possible reasons for different paths may be:



- (a) the charge of M is greater than that of N .
(b) the momentum of M is greater than that of N .
(c) specific charge of M is greater than that of N .
(d) the speed of M is less than that of N .

17. A proton, a deuteron ($q = +e, m = 2.0u$), and an alpha particle ($q = +2e, m = 4.0u$) all having the same kinetic energy enter a region of uniform magnetic field $\vec{B}$, moving perpendicular to $\vec{B}$. The ratio of
- (a) the radius r_d of the deuteron path to the radius r_p of the proton path is $\sqrt{2}$
(b) the radius r_α of the alpha particle path to r_p is 1
(c) the radius r_d of the deuteron path to the radius r_p of the proton path is 2
(d) the radius r_α of the alpha particle path to r_p is $\sqrt{2}$

Comprehension Type

A uniform and constant magnetic field $\vec{B} = (20\hat{i} - 30\hat{j} + 50\hat{k})$ Tesla exists in space. A charged particle with charge to mass ratio $\left(\frac{q}{m}\right) = \frac{10^3}{19} \text{ C/kg}$ enters this region at time $t = 0$ with a velocity $\vec{V} = (20\hat{i} + 50\hat{j} + 30\hat{k})$ m/s. Assume that the charged particle always remains in space having the given magnetic field. (Use $\sqrt{2} = 1.4$)

18. During the further motion of the particle in the magnetic field, the angle between the magnetic field and velocity of the particle
- (a) remains constant (b) increases
(c) decreases (d) may increase or decrease
19. The frequency of the revolution of the particle in cycles per second will be
- (a) $\frac{10^3}{\pi\sqrt{19}}$ (b) $\frac{10^4}{\pi\sqrt{38}}$
(c) $\frac{10^4}{\pi\sqrt{19}}$ (d) $\frac{10^4}{2\pi\sqrt{19}}$
20. The pitch of the helical path of the motion of the particle will be
- (a) $\frac{\pi}{100} \text{ m}$ (b) $\frac{\pi}{125} \text{ m}$
(c) $\frac{\pi}{215} \text{ m}$ (d) $\frac{\pi}{250} \text{ m}$

Answers Key

Subjective Type

1. $\vec{v}(t) = v_{0x} \hat{i} + v_{0y} \cos(\omega t) \hat{j} - v_{0y} (\sin \omega t) \hat{k}$
2. $3.4 \times 10^{-4} \text{ T}$
3. $\vec{B} = (-3.0\hat{i} - 3.0\hat{j} - 4.0\hat{k}) \text{ T}$
4. $\vec{E} = (-500 \text{ V/m}) \hat{j}$
5. $-4.0 \times 10^{-2} \text{ C}$

Single Correct Answer Type

7. (b) 8. (c) 9. (a) 10. (a) 11. (c)
12. (b) 13. (a) 14. (d)

Multiple Correct Answers Type

15. (a, b, d) 16. (a, c, d) 17. (a, b)

Comprehension Type

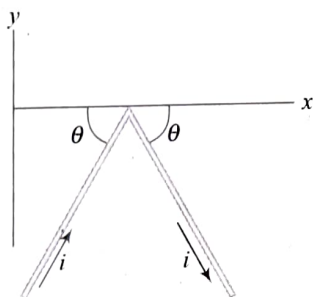
18. (a) 19. (b) 20. (d)

DPP 1.3

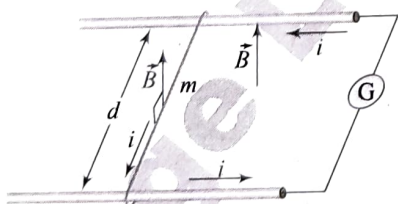
Force on a Current Carrying Conductor in Magnetic Field 1

Subjective Type

1. The bent wire shown in figure lies in a uniform magnetic field. Each straight section is 2.0 m long and makes an angle of $\theta = 60^\circ$ with the x axis, and the wire carries a current of 2.0 A. What is the net magnetic force on the wire in unit-vector notation if the magnetic field is given by (a) $4.0\hat{k}$ T and (b) $4.0\hat{i}$ T?



2. In a metal wire of mass $m = 24.1$ mg can slide with negligible friction on two horizontal parallel rails separated by distance $d = 2.56$ cm. The track lies in a vertical uniform magnetic field of magnitude 56.3 mT. At time $t = 0$, device G is connected to the rails, producing a constant current $i = 9.13$ mA in the wire and rails (even as the wire moves). At $t = 61.1$ ms, what are the wire's (a) speed and (b) direction of motion (left or right)?

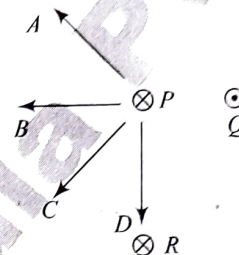


3. A long, rigid conductor, lying along an x -axis, carries a current of 5.0 A in the negative x direction. A magnetic $\vec{B}$ field is present, given by $\vec{B} = 3.0\hat{i} + 8.0x^2\hat{j}$, with x in meters and $\vec{B}$ in milliteslas. Find, in unit-vector notation, the force on the 2.0 m segment of the conductor that lies between $x = 1.0$ m and $x = 3.0$ m.

Single Correct Answer Type

4. Figure shows three long straight wires P , Q and R carrying currents normal to the plane of the paper. All three currents

have the same magnitude. Which arrow best shows the direction of the resultant force on the wire P ?



- (a) A (b) B (c) C (d) D

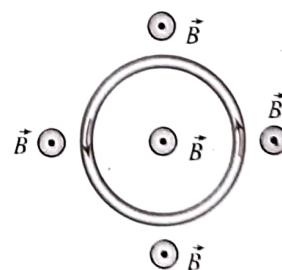
5. A straight wire carrying a current i_1 amp runs along the axis of a circular current i_2 amp. Then the force of interaction between the two current carrying conductors is

- (a) ∞ (b) Zero
(c) $\frac{\mu_0}{4\pi} \frac{2i_1i_2}{r}$ N/m (d) $\frac{2i_1i_2}{r}$ N/m

6. An arbitrary shaped closed coil is made of a wire of length L and a current I ampere is flowing in it. If the plane of the coil is perpendicular to magnetic field $\vec{B}$, the force on the coil is

- (a) Zero (b) IBL
(c) $2IBL$ (d) $\frac{1}{2}IBL$

7. An elastic circular wire of length l carries a current I . It is placed in a uniform magnetic field $\vec{B}$ (Out of paper) such that its plane is perpendicular to the direction of $\vec{B}$. The wire will experience

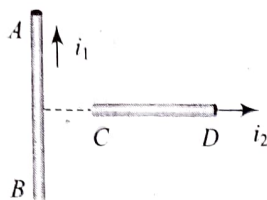


- (a) No force (b) A stretching force
(c) A compressive force (d) A torque

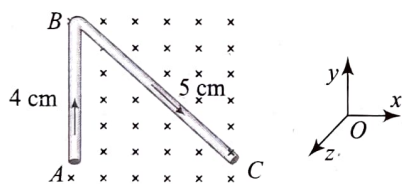
8. An infinitely long, straight conductor AB is fixed and a current is passed through it. Another movable straight wire CD of finite length and carrying current is held

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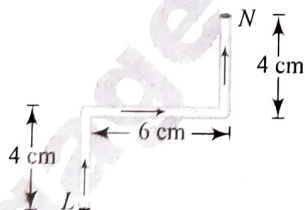
perpendicular to it and released. Neglect weight of the wire



- The rod CD will move upwards parallel to itself
 - The rod CD will move downward parallel to itself
 - The rod CD will move upward and turn clockwise at the same time
 - The rod CD will move upward and turn anti-clockwise at the same time
9. A conductor in the form of a right angle ABC with $AB = 3$ cm and $BC = 4$ cm carries a current of 10 A. There is a uniform magnetic field of 5 T perpendicular to the plane of the conductor. The force on the conductor will be
- 1.5 N
 - 2.0 N
 - 2.5 N
 - 3.5 N
10. A uniform conducting wire ABC has a mass of 10g. A current of 2 A flows through it. The wire is kept in a uniform magnetic field $B = 2$ T. The acceleration of the wire will be

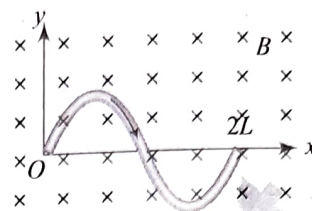


- Zero
 - 12 ms^{-2} along y-axis
 - $1.2 \times 10^{-3} \text{ ms}^{-2}$ along y-axis
 - $0.6 \times 10^{-3} \text{ ms}^{-2}$ along y-axis
11. A current carrying wire LN is bent in the form as shown below. If wire carries a current of 10 A and it is placed in a magnetic field of 5 T which acts perpendicular to the paper outwards then it will experience a force

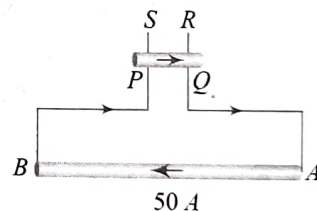


- Zero
- 5 N
- 30 N
- 20 N

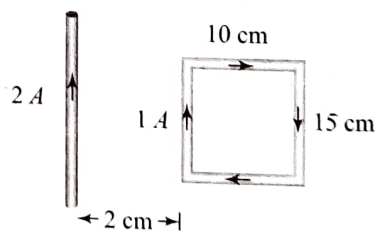
12. A wire carrying a current i is placed in a uniform magnetic field in the form of the curve $y = a \sin \left(\frac{\pi x}{L} \right)$ $0 \leq x \leq 2L$. The force acting on the wire is



- $\frac{iBL}{\pi}$
 - $iBL\pi$
 - $2iBL$
 - Zero
13. Two long wires are hanging freely. They are joined first in parallel and then in series and then are connected with a battery. In both cases, which type of force acts between the two wires
- Attraction force when in parallel and repulsion force when in series
 - Repulsion force when in parallel and attraction force when in series
 - Repulsion force in both cases
 - Attraction force in both cases
14. A long wire AB is placed on a table. Another wire PQ of mass 1.0 g and length 50 cm is set to slide on two rails PS and QR . A current of 50 A is passed through the wires. At what distance above AB , will the wire PQ be in equilibrium



- 25 mm
 - 50 mm
 - 75 mm
 - 100 mm
15. What is the net force on the square coil?



- 25×10^{-7} N moving towards wire
- 25×10^{-7} N moving away from wire
- 35×10^{-7} N moving towards wire
- 35×10^{-7} N moving away from wire

Answers Key

Subjective Type

- (a) $(-16\hat{j})$ N (b) zero
- (a) 3.34×10^{-2} m/s (b) away from the generator
- $(-0.35 \text{ N})\hat{k}$

Single Correct Answer Type

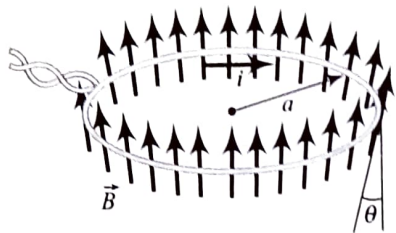
- | | | | | |
|---------|---------|---------|---------|---------|
| 4. (c) | 5. (b) | 6. (a) | 7. (b) | 8. (c) |
| 9. (c) | 10. (b) | 11. (b) | 12. (c) | 13. (a) |
| 14. (a) | 15. (a) | | | |

DPP 1.4

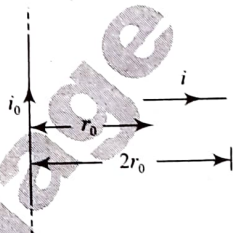
Force on a Current Carrying Conductor in Magnetic Field 2

Subjective Type

1. Figure shows a wire ring of radius a that is perpendicular to the general direction of a radially symmetric, diverging magnetic field. The magnetic field at the ring is everywhere of the same magnitude B , and its direction at the ring everywhere makes an angle θ with a normal to the plane of the ring. The twisted lead wires have no effect on the problem. Find the magnitude of the force the field exerts on the ring if the ring carries a current i .

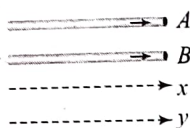


2. A copper rod of mass m rests on two horizontal rails distance L apart and carries a current of i from one rail to the other. The coefficient of static friction between rod and rails is μ_s . What are the (a) magnitude and (b) angle (relative to the vertical) of the smallest magnetic field that puts the rod on the verge of sliding?
3. A straight conductor of length r_0 carrying a current I is placed perpendicular to a long straight conductor which carries a current i_0 as shown in the figure. Find the force of interaction between them.

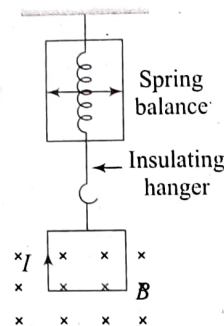


Single Correct Answer Type

4. A and B are two conductors carrying a current i in the same direction. x and y are two electron beams moving in the same direction
- (a) There will be repulsion between A and B attraction between x and y



- (b) There will be attraction between A and B, repulsion between x and y
- (c) There will be repulsion between A and B and also x and y
- (d) There will be attraction between A and B and also x and y
5. A horizontal rod of mass 10 gm and length 10 cm is placed on a smooth plane inclined at an angle of 60° with the horizontal, with the length of the rod parallel to the edge of the inclined plane. A uniform magnetic field of induction B is applied vertically downwards. If the current through the rod is 1.73 ampere, then the value of B for which the rod remains stationary on the inclined plane is
- (a) 1.73 T (b) $\frac{1}{1.73}$ T
- (c) 1 T (d) None of the above
6. A fixed horizontal wire carries a current of 200 A. Another wire having a mass per unit length 10^{-2} kg/m is placed below the first wire at a distance of 2 cm and parallel to it. How much current must be passed through the second wire if it floats in air without any support? What should be the direction of current in it?
- (a) 25 A (direction of current is same to first wire)
- (b) 25 A (direction of current is opposite to first wire)
- (c) 49 A (direction of current is same to first wire)
- (d) 49 A (direction of current is opposite to first wire)
7. A square loop of side a hangs from an insulating hanger of spring balance. The magnetic field of strength B occurs only at the lower edge. It carries a current I . Find the change in the reading of the spring balance if the direction of current is reversed



- (a) IaB (b) $2IaB$
- (c) $\frac{IaB}{2}$ (d) $\frac{3}{2}IaB$

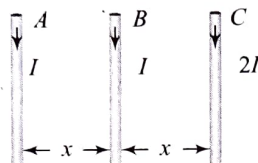
1.10 Magnetism and Electromagnetic Induction

8. Three long straight wires are connected parallel to each other across a battery of negligible internal resistance. The ratio of their resistances are 3 : 4 : 5. What is the ratio of distances of middle wire from the others if the net force experienced by it is zero?

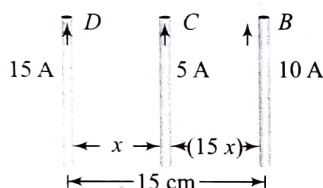
(a) 4 : 3 (b) 3 : 1
(c) 5 : 3 (d) 2 : 3

9. A, B and C are parallel conductors of equal length carrying currents I , I and $2I$ respectively. Distance between A and B is x . Distance between B and C is also x . F_1 is the force exerted by B on A and F_2 is the force exerted by B on C. Choose the correct answer

(a) $F_1 = 2F_2$
(b) $F_2 = 2F_1$
(c) $F_1 = F_2$
(d) $F_1 = -F_2$

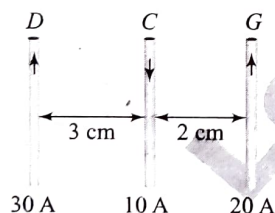


10. Three long, straight and parallel wires carrying currents are arranged as shown in the figure. The wire C which carries a current of 5.0 amp is so placed that it experiences no force. The distance of wire C from wire D is then



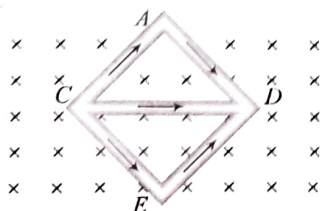
(a) 9 cm (b) 7 cm (c) 5 cm (d) 3 cm

11. Three long, straight parallel wires carrying current, are arranged as shown in the figure. The force experienced by a 25 cm length of wire C is

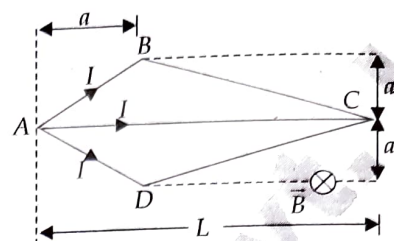


(a) 10^{-3} N (b) 2.5×10^{-3} N
(c) Zero (d) 1.5×10^{-3} N

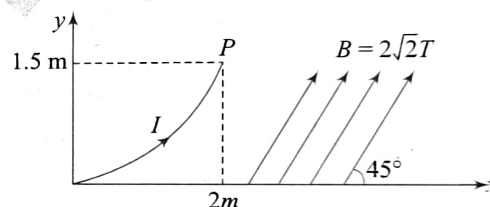
12. Same current $i = 2$ A is flowing in a wire frame as shown in the figure. The frame is a combination of two equilateral triangles ACD and CDE of side 1 m. It is placed in uniform magnetic field $B = 4$ T acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is



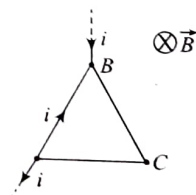
- (a) 24 N (b) Zero
(c) 16 N (d) 8 N
13. Find the magnitude of magnetic force on the frame, as shown. The magnetic field acting as shown:



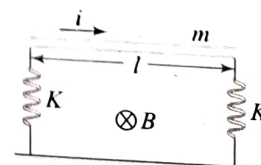
- (a) zero
(b) $2IB[a\sqrt{2} + \{a^2 + (L-a)^2\}^{1/2}] + ILB$
(c) $3ILB$
(d) ILB
14. A parabolic wire as shown in the figure is located in x - y plane and carries a current $I = 10$ amp. A uniform magnetic field of intensity $2\sqrt{2}T$, making an angle of 45° with x -axis exists throughout the plane. If the coordinates of end point 'P' of wire are (2 m, 1.5 m), then the total force acting on the wire is:



- (a) $40 N\hat{k}$ (b) $10 N\hat{k}$
(c) $-10 N\hat{k}$ (d) $-40 N\hat{k}$
15. Figure shows an equilateral triangle ABC of side l carrying currents, placed in uniform magnetic field B. The magnitude of magnetic force on triangle is

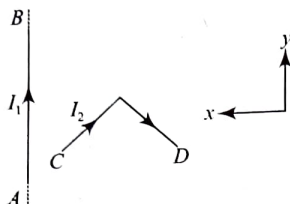


- (a) ilB (b) $2ilB$ (c) $3ilB$ (d) zero
16. A horizontal metallic rod of mass ' m ' and length ' l ' is supported by two vertical identical springs of spring constant ' K ' each and natural length l_0 . A current ' i ' is flowing in the rod in the direction shown. If the rod is in equilibrium, then the length of each spring in this state is:

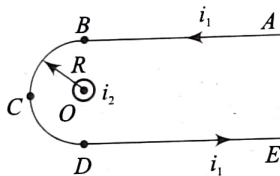


- (a) $l_0 + \frac{ilB - mg}{K}$ (b) $l_0 + \frac{ilB - mg}{2K}$
 (c) $l_0 + \frac{mg - ilB}{2K}$ (d) $l_0 + \frac{mg - ilB}{K}$

17. In the figure shown a current I_1 is established in the long straight wire AB . Another wire CD carrying current I_2 is placed in the plane of the paper. The line joining the ends of this wire is perpendicular to the wire AB . The resultant force on the wire CD is:



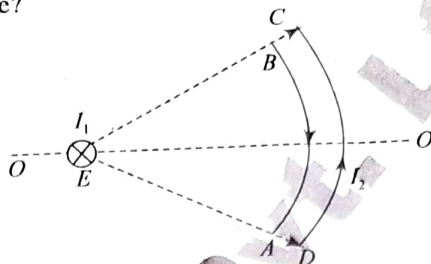
- (a) zero
 (b) towards negative x-axis
 (c) towards positive y-axis
 (d) none of these
18. ABCDE is a very long wire carrying current i_1 as shown. The portion BCD is a semicircle with centre at O . Another very long wire passes through point O , perpendicular to the plane of $ABCDE$ and it carries current i_2 outside the plane of paper. The two wires



- (a) attract each other
 (b) repel each other
 (c) do not exert any force on each other
 (d) nothing can be said.

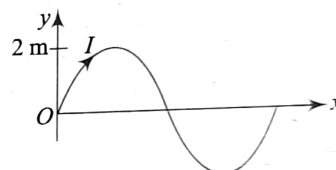
Multiple Correct Answers Type

19. Which of the following statements is correct in the given figure?



Infinitely long wire at E kept perpendicular to paper carrying current inwards:

- (a) Net force on loop is zero
 (b) Net torque on loop is zero
 (c) Loop will rotate clockwise about axis OO' when seen from O .
 (d) Loop will rotate anticlockwise about OO' when seen from O
20. A current carrying conductor is in the form of a sine curve as shown, which carries current I . If the equation of this curve is $Y = 2 \sin \left(\frac{\pi x}{L} \right)$ and a uniform magnetic field B exists in space.



- (a) Force on wire is BIL if field is along Z axis
 (b) Force on wire is $2BIL$ if field is along Y axis
 (c) Force on wire is zero if field is along X axis
 (d) Force on wire is BIL if field is in the XY plane making an angle 30° with X -axis

Answers Key

Subjective Type

1. $2\pi aiB \sin \theta$
 2. (a) 0.10 T (b) 31°
 3. $\frac{\mu_0 i i_0}{2\pi} \ln 2$

Single Correct Answer Type

4. (b) 5. (c) 6. (c) 7. (b) 8. (c)
 9. (d) 10. (a) 11. (c) 12. (a) 13. (c)
 14. (b) 15. (a) 16. (b) 17. (d) 18. (c)

Multiple Correct Answers Type

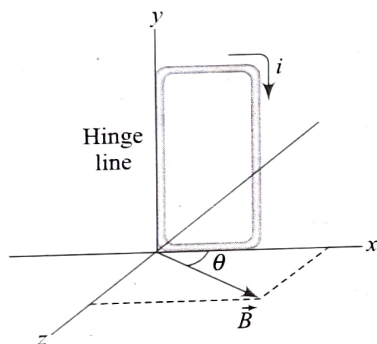
19. (a, c) 20. (b, c, d)

DPP 1.5

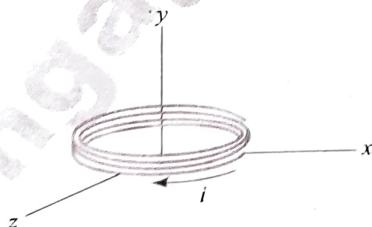
Magnetic Dipole

Subjective Type

1. Figure shows a rectangular 20-turn coil of wire of dimensions 10 cm by 5.0 cm. It carries a current of 0.10 A and is hinged along one long side. It is mounted in the xy plane, at angle $\theta = 30^\circ$ to the direction of a uniform magnetic field of magnitude 0.50 T. In unit-vector notation, what is the torque acting on the coil about the hinge line?

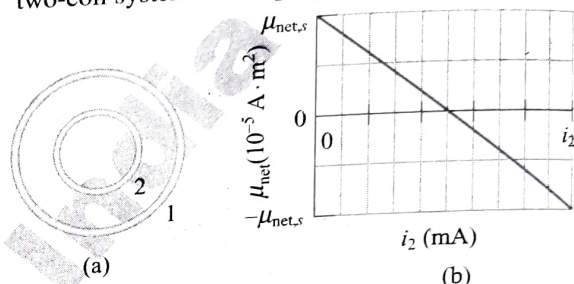


2. A current loop, carrying a current of 5.0 A, is in the shape of a right triangle with sides 30, 40, and 50 cm. The loop is in a uniform magnetic field of magnitude 80 mT whose direction is parallel to the current in the 50 cm side of the loop. Find the magnitude of (a) the magnetic dipole moment of the loop and (b) the torque on the loop.
3. The coil in figure carries current $i = 2.00$ A in the direction indicated, is parallel to an xz plane, has 3.00 turns and an area of $4.00 \times 10^{-3} \text{ m}^2$, and lies in a uniform magnetic field $\vec{B} = (2.00\hat{i} - 3.00\hat{j} - 4.00\hat{k}) \text{ mT}$. What are (a) the orientation energy of the coil in the magnetic field and (b) the torque (in unit-vector notation) on the coil due to the magnetic field?



4. In Figure (a), two concentric coils, lying in the same plane, carry currents in opposite directions. The current in the larger coil 1 is fixed. Current i_2 in coil 2 can be varied. Figure (b) gives the net magnetic moment of the two-coil

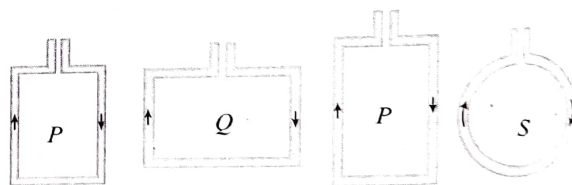
system as a function of i_2 . The vertical axis scale is set by $\mu_{\text{net},S} = 2.0 \times 10^{-5} \text{ A} \cdot \text{m}^2$, and the horizontal axis scale is set by $i_{2,S} = 10.0 \text{ mA}$. If the current in coil 2 is then reversed, what is the magnitude of the net magnetic moment of the two-coil system when $i_2 = 7.0 \text{ mA}$?



5. A spherical shell of radius 'R' and uniformly charged with charge 'Q' is rotating about its axis with frequency 'f'. Find the magnetic moment of the sphere.

Single Correct Answer Type

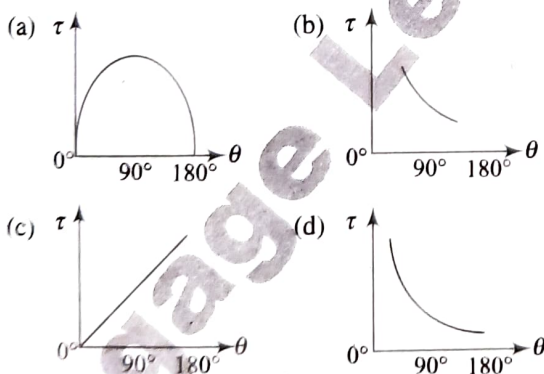
6. Four wires each of length 2.0 metres are bent into four loops P, Q, R and S and then suspended into uniform magnetic field. Same current is passed in each loop. Which statement is correct?



- (a) Couple on loop P will be the highest
 (b) Couple on loop Q will be the highest
 (c) Couple on loop R will be the highest
 (d) Couple on loop S will be the highest
7. Two wires of the same length are shaped into a square and a circle. If they carry same current, ratio of the magnetic moment is
- (a) $2 : \pi$ (b) $\pi : 2$ (c) $\pi : 4$ (d) $4 : \pi$
8. A wire of length L metre carrying a current of I ampere is bent in the form of a circle. Its magnitude of magnetic moment will be

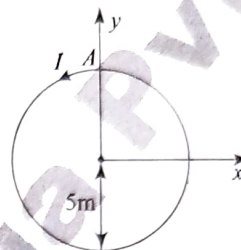
- (a) $\frac{IL}{4\pi}$ (b) $\frac{IL^2}{4\pi}$ (c) $\frac{I^2L^2}{4\pi}$ (d) $\frac{I^2L}{4\pi}$

9. A thin circular wire carrying a current I has a magnetic moment M . The shape of the wire is changed to a square and it carries the same current. It will have a magnetic moment
- (a) M (b) $\frac{4}{\pi^2} M$
 (c) $\frac{4}{\pi} M$ (d) $\frac{\pi}{4} M$
10. A current carrying circular loop is freely suspended by a long thread. The plane of the loop will point in the direction
- (a) wherever left free
 (b) North-south
 (c) East-west
 (d) At 45° with the east-west direction
11. A triangular loop of side l carries a current I . It is placed in a magnetic field B such that the plane of the loop is in the direction of B . The torque on the loop is
- (a) Zero (b) IBl
 (c) $\frac{\sqrt{3}}{2} I l^2 B^2$ (d) $\frac{\sqrt{3}}{4} I B l^2$
12. A current carrying loop is free to turn in a uniform magnetic field. The loop will then come into equilibrium when its plane is inclined at
- (a) 0° to the direction of the field
 (b) 45° to the direction of the field
 (c) 90° to the direction of the field
 (d) 135° to the direction of the field
13. A current i flows in a circular coil of radius r . If the coil is placed in a uniform magnetic field B with its plane parallel to the field, magnitude of the torque that acts on the coil is
- (a) Zero (b) $2\pi r i B$
 (c) $\pi r^2 i B$ (d) $2\pi r^2 i B$
14. The $(\tau-\theta)$ graph for a coil is



15. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field B . The work done to rotate the loop by 30° about an axis perpendicular to its plane is
- (a) MB (b) $\sqrt{3} \frac{MB}{2}$
 (c) $\frac{MB}{2}$ (d) zero

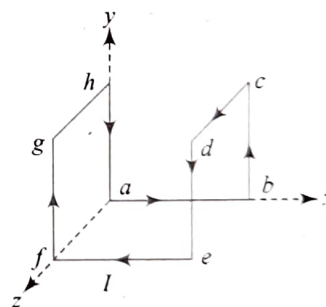
16. A circular coil of radius 4 cm has 50 turns. In this coil a current of 2 A is flowing. It is placed in a magnetic field of 0.1 weber/m^2 . The amount of work done in rotating it through 180° from its equilibrium position will be
- (a) 0.1 J (b) 0.2 J
 (c) 0.4 J (d) 0.8 J
17. A ring of radius 5 m is lying in the x - y plane and is carrying current of 1 A in anticlockwise sense. If a uniform magnetic field $\vec{B} = 3\hat{i} + 4\hat{j}$ is switched on, then the coordinates of point about which the loop will lift up is:



- (a) (3, 4) (b) (4, 3)
 (c) (3, 0) (d) (0, 3)

Comprehension Type

A current I amperes flows through a loop abcdefgha along the edge of a cube of width l metres as shown in figure. One corner 'a' of the loop lies at origin.



18. This current path (abcdefgha) can be treated as a superposition of three square loops carrying current I . Choose the correct option?
- (a) fghaf, fabef, ebcd (b) fghaf, fabef, fgdef
 (c) fghaf, abcha, ebcd (d) fgdef, fabef, ebcd
19. The unit vector in the direction of magnetic field at the centre of cube abcdefgh of width λ is given by
- (a) $\hat{i}$ (b) $-\hat{j}$
 (c) $\frac{2\hat{i} - \hat{j}}{\sqrt{5}}$ (d) $\hat{k}$
20. Now if a uniform external magnetic field is $\vec{B} = B_0 \hat{j}$ is switched on, then the unit vector in the direction of torque due to external magnetic field ($\vec{B}$) acting on the current carrying loop (abcdefgha) is
- (a) $\hat{k}$ (b) $-\hat{i}$
 (c) $\frac{2\hat{i} - \hat{j}}{\sqrt{5}}$ (d) none of these

Answers Key

Subjective Type

1. $(-4.3 \times 10^{-3} \text{ N.m}) \hat{j}$
2. (a) 0.30 A.m^2 (b) $2.4 \times 10^{-2} \text{ N.m}$
3. (a) $-7.20 \times 10^{-5} \text{ J}$
(b) $(9.60 \times 10^{-5} \text{ N.m}) \hat{i} + (4.80 \times 10^{-5} \text{ N.m}) \hat{k}$
4. $4.8 \times 10^{-5} \text{ A.m}^2$
5. $\frac{QR^2\omega}{3}$

Single Correct Answer Type

- | | | | | |
|---------|---------|---------|---------|---------|
| 6. (d) | 7. (c) | 8. (b) | 9. (d) | 10. (c) |
| 11. (d) | 12. (c) | 13. (c) | 14. (a) | 15. (a) |
| 16. (a) | 17. (a) | | | |

Comprehension Type

- | | | |
|---------|---------|---------|
| 18. (a) | 19. (b) | 20. (d) |
|---------|---------|---------|

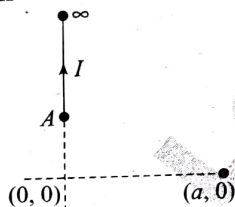
Sources of Magnetic Field

DPP 2.1

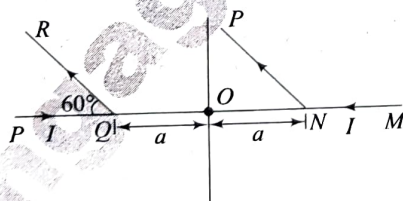
Magnetic Field Due to Current Carrying Straight Wire

Subjective Type

1. An infinitely long wire carrying current I is along Y axis such that its one end is at point $A(0, b)$ while the wire extends up to $+\infty$. The magnitude of magnetic field strength at Point $(a, 0)$ is

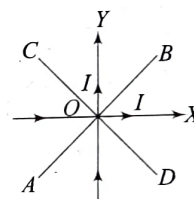


2. Two long wires PQR and MNP carry equal current I as shown such that QR and NP are parallel. Find the magnetic field at origin O .

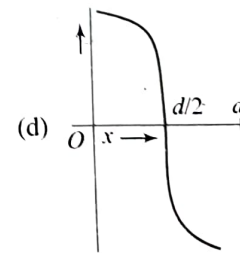
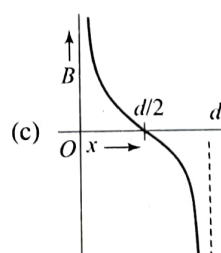
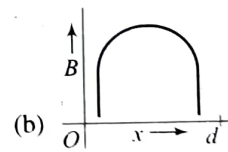
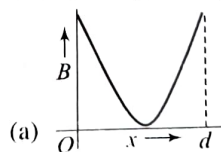


Single Correct Answer Type

3. Two very thin metallic wires placed along X and Y -axis carry equal currents as shown here. AB and CD are lines at 45° with the axes with origin of axes at O . The magnetic field will be zero on the line



- (a) AB
 - (b) CD
 - (c) Segment OB only of line AB
 - (d) Segment OC only of line CD
4. Two parallel beams of protons and electrons, carrying equal currents are fixed at a separation d . The protons and electrons move in opposite directions. P is a point on a line joining the beams, at a distance x from any one beam. The magnetic field at P is B . If B is plotted against x , which of the following best represents the resulting curve

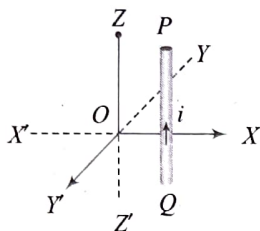


2.2 Magnetism and Electromagnetic Induction

5. A straight section PQ of a circuit lies along the X -axis from $x = -\frac{a}{2}$ to $x = \frac{a}{2}$ and carries a steady current i . The magnetic field due to the section PQ at a point $X = +a$ will be

- (a) proportional to a (b) proportional to a^2
(c) proportional to $1/a$ (d) zero

6. A vertical wire kept in Z - X plane carries a current from Q to P (see figure). The magnetic field due to current will have the direction at the origin O along



- (a) OX (b) OX'
(c) OY (d) OY'

7. A long straight wire carrying current of 30 A is placed in an external uniform magnetic field of induction $4 \times 10^{-4} \text{ T}$. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction in tesla at a point 2.0 cm away from the wire is

- (a) 10^{-4} (b) 3×10^{-4}
(c) 5×10^{-4} (d) 6×10^{-4}

8. A current i is flowing in a straight conductor of length L .

The magnetic induction at a point distant $\frac{L}{4}$ from its centre will be

- (a) $\frac{4\mu_0 i}{\sqrt{5}\pi L}$ (b) $\frac{\mu_0 i}{2\pi L}$
(c) $\frac{\mu_0 i}{\sqrt{2}L}$ (d) Zero

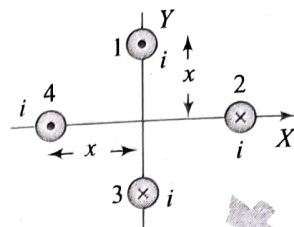
9. Two parallel long wires carry currents i_1 and i_2 with $i_1 > i_2$. When the currents are in the same direction, the magnetic field midway between the wires is $10 \mu\text{T}$. When the direction of i_2 is reversed, it becomes $40 \mu\text{T}$. The ratio i_1/i_2 is

- (a) 3 : 4 (b) 11 : 7
(c) 7 : 11 (d) 5 : 3

10. Two straight long conductors AOB and COD are perpendicular to each other and carry currents i_1 and i_2 . The magnitude of the magnetic induction at a point P at a distance a from the point O in a direction perpendicular to the plane $ACBD$ is

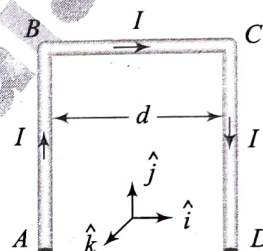
- (a) $\frac{\mu_0}{2\pi a}(i_1 + i_2)$ (b) $\frac{\mu_0}{2\pi a}(i_1 - i_2)$
(c) $\frac{\mu_0}{2\pi a}(i_1^2 + i_2^2)^{1/2}$ (d) $\frac{\mu_0}{2\pi a} \frac{i_1 i_2}{(i_1 + i_2)}$

11. What will be the resultant magnetic field at origin due to four infinite length wires, if each wire produces magnetic field ' B ' at origin



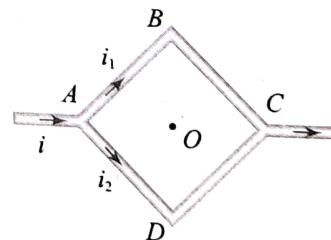
- (a) $4B$ (b) $\sqrt{2}B$
(c) $2\sqrt{2}B$ (d) Zero

12. AB and CD are long straight conductor, distance d apart, carrying a current I . The magnetic field at the midpoint of BC is



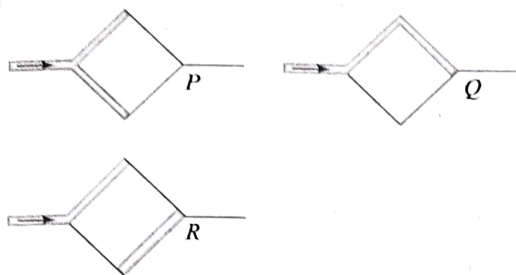
- (a) $\frac{-\mu_0 I}{2\pi d} \hat{k}$ (b) $\frac{-\mu_0 I}{\pi d} \hat{k}$
(c) $\frac{-\mu_0 I}{4\pi d} \hat{k}$ (d) $\frac{-\mu_0 I}{8\pi d} \hat{k}$

13. Figure shows a square loop $ABCD$ with edge length a . The resistance of the wire ABC is r and that of ADC is $2r$. The value of magnetic field at the centre of the loop assuming uniform wire is



- (a) $\frac{\sqrt{2}\mu_0 i}{3\pi a} \odot$ (b) $\frac{\sqrt{2}\mu_0 i}{3\pi a} \otimes$
(c) $\frac{\sqrt{2}\mu_0 i}{\pi a} \odot$ (d) $\frac{\sqrt{2}\mu_0 i}{\pi a} \otimes$

14. Two thick wires and two thin wires, all of the same materials and same length form a square in the three different ways P , Q and R as shown in the figure with current connection shown, the magnetic field at the centre of the square is zero in cases



- (a) In P only
(b) In P and Q only
(c) In Q and R only
(d) P and R only

15. In the following figure a wire bent in the form of a regular polygon of n sides is inscribed in a circle of radius a . Net magnetic field at centre will be

- (a) $\frac{\mu_0 i}{2\pi a} \tan \frac{\pi}{n}$
(b) $\frac{\mu_0 ni}{2\pi a} \tan \frac{\pi}{n}$
(c) $\frac{2}{\pi} \frac{ni}{a} \mu_0 \tan \frac{\pi}{n}$
(d) $\frac{ni}{2a} \mu_0 \tan \frac{\pi}{n}$



Answers Key

Subjective Type

- $\frac{\mu_0 I}{4\pi a} \left(1 - \frac{b}{\sqrt{a^2 + b^2}} \right)$
- $\frac{\mu_0 I}{2\sqrt{3}\pi a}$ out of the page

Single Correct Answer Type

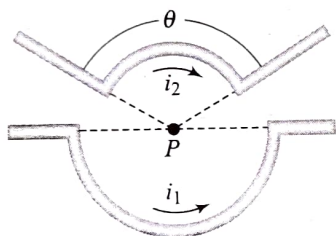
- | | | | | |
|---------|---------|---------|---------|---------|
| 3. (a) | 4. (c) | 5. (d) | 6. (d) | 7. (c) |
| 8. (a) | 9. (d) | 10. (c) | 11. (c) | 12. (b) |
| 13. (b) | 14. (d) | 15. (b) | | |

DPP 2.2

Magnetic Field Due to Current Carrying Circular Wire Loop 1

Subjective Type

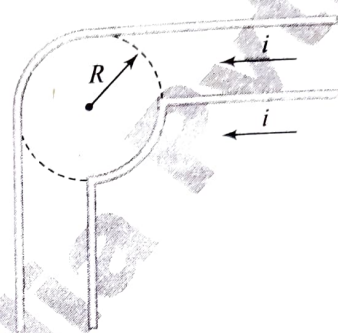
1. Figure shows two current segments. The lower segment carries a current of $i_1 = 0.40$ A and includes a semicircular arc with radius 5.0 cm, angle 180° , and center point P . The upper segment carries current $i_2 = 2i_1$ and includes a circular arc with radius 4.0 cm, angle 120° , and the same center point P . What are the (a) magnitude and (b) direction of the net magnetic field $\vec{B}$ at P for the indicated current directions? What are the (c) magnitude and (d) direction of $\vec{B}$ if i_1 is reversed?



2. A current is set up in a wire loop consisting of a semicircle of radius 4.00 cm, a smaller concentric semicircle, and two radial straight lengths, all in the same plane. Figure (a) shows the arrangement but is not drawn to scale. The magnitude of the magnetic field produced at the center of curvature is $74.25 \mu\text{T}$. The smaller semicircle is then flipped over (rotated) until the loop is again entirely in the same plane figure (b). The magnetic field produced at the (same) center of curvature now has magnitude $15.75 \mu\text{T}$ and its direction is reversed from the initial magnetic field. What is the radius of the smaller semicircle?



3. In the figure two infinitely long wires carry equal currents i . Each follows a 90° arc on the circumference of the same circle of radius R . Show that the magnetic field $\vec{B}$ at the center of the circle is the same as the field $\vec{B}$ a distance R below an infinite straight wire carrying a current i to the left.



Single Correct Answer Type

4. A coil carrying a heavy current and having large number of turns mounted in a N - S vertical plane and a current flows in clockwise direction. A small magnetic needle at its center will have its north pole in
 (a) East-north direction (b) West-north direction
 (c) East-south direction (d) West-south direction
5. An electron is revolving round a proton, producing a magnetic field of 16 weber/m^2 in a circular orbit of radius $1 \text{ \AA}$. Its angular velocity will be
 (a) 10^{17} rad/sec (b) $1/2\pi \times 10^{12} \text{ rad/sec}$
 (c) $2\pi \times 10^{12} \text{ rad/sec}$ (d) $4\pi \times 10^{12} \text{ rad/sec}$
6. A thin wire of length l is carrying a constant current. The wire is bent to form a circular coil. If radius of the coil, thus formed, is equal to R and number of turns in it is equal to n , then which of the following graphs represent (s) variation of magnetic field induction (B) at centre of the coil
- (a)

(c)

(b)

(d)
7. A neutral point is obtained at the centre of a vertical circular coil carrying current. The angle between the plane of the coil and the magnetic meridian is
 (a) 0° (b) 45° (c) 60° (d) 90°

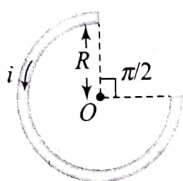
8. Two concentric coplanar circular loops of radii r_1 and r_2 carry currents of respectively i_1 and i_2 in opposite directions (one clockwise and the other anticlockwise.) The magnetic induction at the centre of the loops is half that due to i_1 alone at the centre. If $r_2 = 2r_1$, the value of i_2/i_1 is

- (a) 2 (b) 1/2
(c) 1/4 (d) 1

9. Two similar coils are kept mutually perpendicular such that their centres coincide. At the centre, find the ratio of the magnetic field due to one coil and the resultant magnetic field by both coils, if the same current is flown

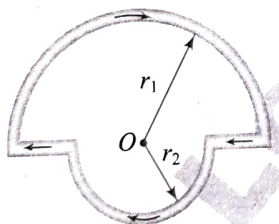
- (a) $1 : \sqrt{2}$ (b) $1 : 2$
(c) $2 : 1$ (d) $\sqrt{3} : 1$

10. A current i ampere flows in a circular arc of wire whose radius is R , which subtend an angle $3\pi/2$ radian at its centre. The magnetic induction B at the centre is



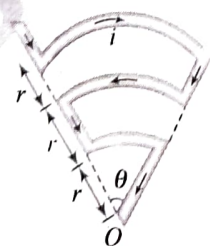
- (a) $\frac{\mu_0 i}{R}$ (b) $\frac{\mu_0 i}{2R}$
(c) $\frac{2\mu_0 i}{R}$ (d) $\frac{3\mu_0 i}{8R}$

11. In the figure shown there are two semicircles of radii r_1 and r_2 in which a current i is flowing. The magnetic induction at the centre O will be



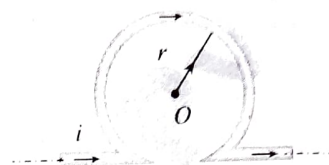
- (a) $\frac{\mu_0 i}{r}(r_1 + r_2)$ (b) $\frac{\mu_0 i}{4}(r_1 - r_2)$
(c) $\frac{\mu_0 i}{4} \left(\frac{r_1 + r_2}{r_1 r_2} \right)$ (d) $\frac{\mu_0 i}{4} \left(\frac{r_2 - r_1}{r_1 r_2} \right)$

12. Find magnetic field at O



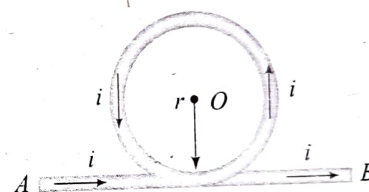
- (a) $\frac{5\mu_0 i \theta}{24\pi r}$ (b) $\frac{\mu_0 i \theta}{24\pi r}$
(c) $\frac{11\mu_0 i \theta}{24\pi r}$ (d) Zero

13. An infinitely long straight conductor is bent into the shape as shown in the figure. It carries a current of i ampere and the radius of the circular loop is r metre. Then the magnetic induction at its centre will be



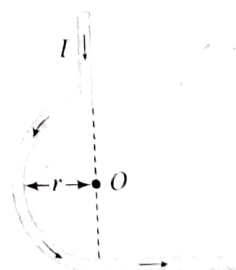
- (a) $\frac{\mu_0 2i}{4\pi r}(\pi + 1)$ (b) $\frac{\mu_0 2i}{4\pi r}(\pi - 1)$
(c) Zero (d) Infinite

14. A part of a long wire carrying a current i is bent into a circle of radius r as shown in the figure. The net magnetic field at the centre O of the circular loop is



- (a) $\frac{\mu_0 i}{4r}$ (b) $\frac{\mu_0 i}{2r}$
(c) $\frac{\mu_0 i}{2\pi r}(\pi + 1)$ (d) $\frac{\mu_0 i}{2\pi r}(\pi - 1)$

15. In the figure, what is the magnetic field at the point O ?



- (a) $\frac{\mu_0 I}{4\pi r}$ (b) $\frac{\mu_0 I}{4\pi r} + \frac{\mu_0 I}{2\pi r}$
(c) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{4\pi r}$ (d) $\frac{\mu_0 I}{4r} - \frac{\mu_0 I}{4\pi r}$

Answers Key**Subjective Type**

1. (a) $1.7 \times 10^{-6} \text{ T}$ (b) into the page.
(c) $6.7 \times 10^{-6} \text{ T}$ (d) into the page
2. 2 cm
3. $\frac{\mu_0 i}{2\pi R}$

Single Correct Answer Type

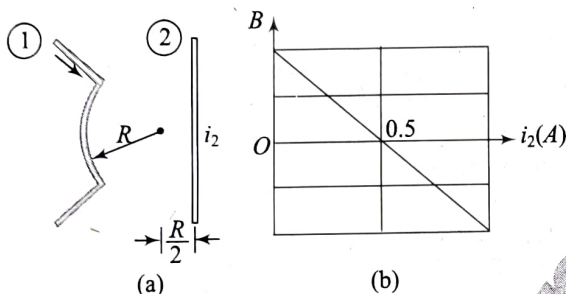
- | | | | | |
|---------|---------|-----------|---------|---------|
| 4. (b) | 5. (a) | 6. (b, c) | 7. (d) | 8. (d) |
| 9. (a) | 10. (d) | 11. (c) | 12. (a) | 13. (b) |
| 14. (c) | 15. (c) | | | |

DPP 2.3

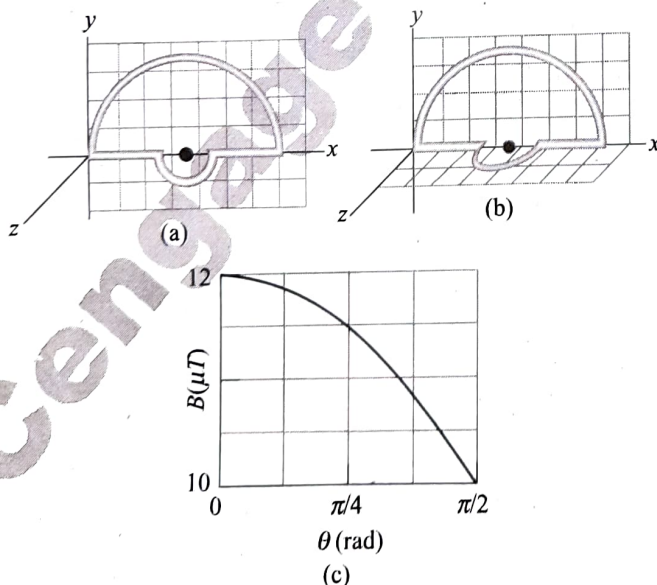
Magnetic Field Due to Current Carrying Circular Wire Loop 2

Subjective Type

1. Figure (a) shows two wires, each carrying a current. Wire 1 consists of a circular arc of radius R and two radial lengths; it carries current $i_1 = 2.0$ A in the direction indicated. Wire 2 is long and straight; it carries a current i_2 that can be varied; and it is at distance $R/2$ from the center of the arc. The net magnetic field $\vec{B}$ due to the two currents is measured at the center of curvature of the arc. Figure (b) is a plot of the component of $\vec{B}$ in the direction perpendicular to the figure as a function of current i_2 . What is the angle subtended by the arc?

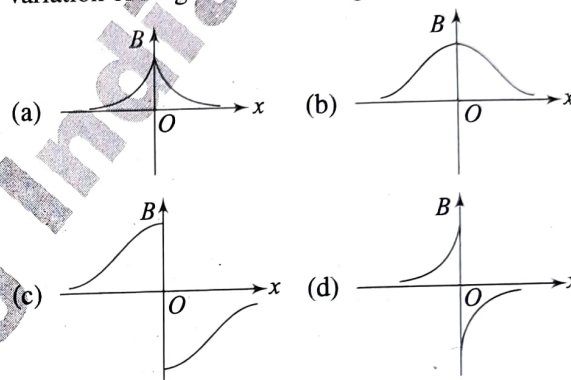


2. The current-carrying wire loop in Fig. (a) lies all in one plane and consists of a semicircle of radius 10.0 cm, a smaller semicircle with the same center, and two radial lengths. The smaller semicircle is rotated out of that plane by angle θ , until it is perpendicular to the plane [Fig. (b)]. Figure (c) gives the magnitude of the net magnetic field at the center of curvature versus angle θ . What is the radius of the smaller semicircle?

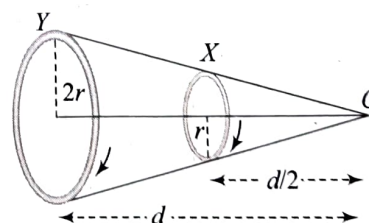


Single Correct Answer Type

3. A circular coil is in y - z plane with centre at origin. The coil is carrying a constant current. Assuming direction of magnetic field at $x = -25$ cm to be positive direction of magnetic field, which of the following graphs shows variation of magnetic field along x -axis



4. A circular current carrying coil has a radius R . The distance from the centre of the coil on the axis where the magnetic induction will be $\frac{1}{8}$ th to its value at the centre of the coil is
- (a) $\frac{R}{\sqrt{3}}$ (b) $R\sqrt{3}$
 (c) $2\sqrt{3}R$ (d) $\frac{2}{\sqrt{3}}R$
5. Two circular coils X and Y , having equal number of turns, carry equal currents in the same sense and subtend same solid angle at point O . If the smaller coil, X is midway between O and Y , then if we represent the magnetic induction due to bigger coil Y at O as B_Y and that due to smaller coil X at O as B_X , then



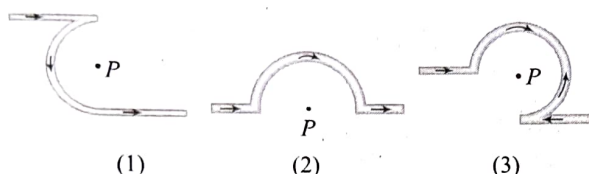
- (a) $\frac{B_Y}{B_X} = 1$ (b) $\frac{B_Y}{B_X} = 2$
 (c) $\frac{B_Y}{B_X} = \frac{1}{2}$ (d) $\frac{B_Y}{B_X} = \frac{1}{4}$

2.8 Magnetism and Electromagnetic Induction

6. The field normal to the plane of a wire of n turns and radius r which carries a current i is measured on the axis of the coil at a small distance h from the centre of the coil. This is smaller than the field at the centre by the fraction

(a) $\frac{3h^2}{2r^2}$ (b) $\frac{2h^2}{3r^2}$
(c) $\frac{3r^2}{2h^2}$ (d) $\frac{2r^2}{3h^2}$

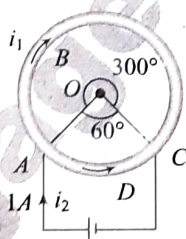
7. The magnetic field at the centre of a circular coil of radius r is π times that due to a long straight wire at a distance r from it, for equal currents. The following figures show three cases: in all cases the circular part has radius r and straight ones are infinitely long. For same current, the B field at the centre P in cases 1, 2, 3 has the ratio



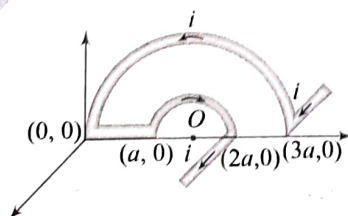
(a) $\left(-\frac{\pi}{2}\right) : \left(\frac{\pi}{2}\right) : \left(\frac{3\pi}{4} - \frac{1}{2}\right)$
(b) $\left(-\frac{\pi}{2} + 1\right) : \left(\frac{\pi}{2} + 1\right) : \left(\frac{3\pi}{4} + \frac{1}{2}\right)$
(c) $-\frac{\pi}{2} : \frac{\pi}{2} : 3\frac{\pi}{4}$
(d) $\left(-\frac{\pi}{2} - 1\right) : \left(\frac{\pi}{2} - \frac{1}{4}\right) : \left(\frac{3\pi}{4} + \frac{1}{2}\right)$

8. A cell is connected between the points A and C of a circular conductor $ABCD$ of centre O with angle $AOC = 60^\circ$. If B_1 and B_2 are the magnitudes of the magnetic fields at O due to the currents in ABC and ADC respectively, the ratio $\frac{B_1}{B_2}$ is

(a) 0.2 (b) 6 (c) 1 (d) 5

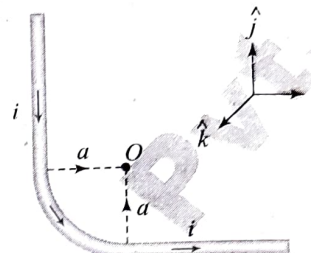


9. In the given figure net magnetic field at O will be



(a) $\frac{2\mu_0 i}{3\pi a} \sqrt{4 - \pi^2}$ (b) $\frac{\mu_0 i}{3\pi a} \sqrt{4 + \pi^2}$
(c) $\frac{2\mu_0 i}{3\pi a^2} \sqrt{4 + \pi^2}$ (d) $\frac{2\mu_0 i}{3\pi a} \sqrt{(4 + \pi^2)}$

10. The unit vectors $\hat{i}$, $\hat{j}$ and $\hat{k}$ are as shown below. What will be the magnetic field at O in the following figure?

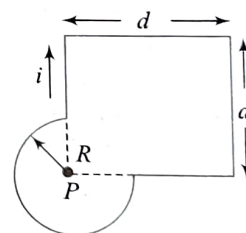


(a) $\frac{\mu_0 i}{4\pi a} \left(2 - \frac{\pi}{2}\right) \hat{j}$ (b) $\frac{\mu_0 i}{4\pi a} \left(2 + \frac{\pi}{2}\right) \hat{j}$
(c) $\frac{\mu_0 i}{4\pi a} \left(2 + \frac{\pi}{2}\right) \hat{i}$ (d) $\frac{\mu_0 i}{4\pi a} \left(2 + \frac{\pi}{2}\right) \hat{k}$

11. A straight wire of length (π^2) metre is carrying a current of 2 A and the magnetic field due to it is measured at a point distant 1 cm from it. If the wire is to be bent into a circle and is to carry the same current as before, the ratio of the magnetic field at its centre to that obtained in the first case would be

(a) 50 : 1 (b) 1 : 50
(c) 100 : 1 (d) 1 : 100

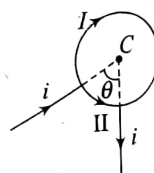
12. For the current carrying wire, show that the magnetic field at P is



(a) $\frac{\mu_0 i}{4\pi} \left(\frac{3\pi}{2R} + \frac{\sqrt{2}}{d}\right) \odot$ (b) $\frac{\mu_0 i}{4\pi} \left(\frac{3\pi}{2R} + \frac{\sqrt{2}}{d}\right) \otimes$
(c) $\frac{\mu_0 i}{4\pi} \left(\frac{3\pi}{2R} - \frac{\sqrt{2}}{d}\right) \odot$ (d) $\frac{\mu_0 i}{4\pi} \left(\frac{3\pi}{2R} - \frac{\sqrt{2}}{d}\right) \otimes$

Multiple Correct Answers Type

13. L is the circular ring made of a uniform wire. Current enters and leaves the ring through straight conductors which, if produced, would have passed through the centre C of the ring. The magnetic field at C

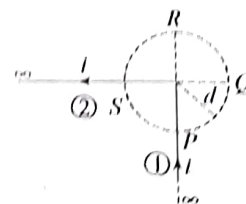


- (a) due to the straight conductors is zero
- (b) due to the loop is zero
- (c) due to path II is proportional to θ .
- (d) due to the Path I is proportional to $(\pi - \theta)$.

14. Two circular coils A and B with their centres lying on the same axis have same number of turns and carry equal currents in the same sense. They are separated by a distance, have different diameters but subtend same angle at a point P lying on their common axis. The coil B lies exactly midway between coil A and the point P . The magnetic field at point P due to coils A and B is B_1 and B_2 respectively.

- (a) $B_1 > B_2$
- (b) $B_1 < B_2$
- (c) $\frac{B_1}{B_2} = 2$
- (d) $\frac{B_1}{B_2} = \frac{1}{2}$

15. Figure shows a long wire bent at the middle to form a right angle.



- (a) The magnitude of magnetic field at the points P , Q , R and S are same.
- (b) The direction of magnetic field at points P and S are same.
- (c) The magnitude of magnetic field at points P and S is zero.
- (d) The direction of magnetic field at points R and S are opposite to each other.

Answers Key

Subjective Type

1. 1 rad 2. 2.3 cm

Single Correct Answer Type

3. (b) 4. (b) 5. (c) 6. (a) 7. (a)
8. (c) 9. (b) 10. (d) 11. (b) 12. (b)

Multiple Correct Answers Type

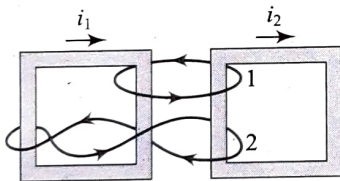
13. (a, b) 14. (b, d) 15. (a, b, d)

DPP 2.4

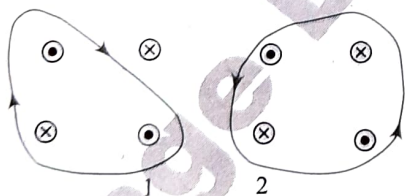
Ampere Law

Subjective Type

- The current density $\vec{J}$ inside a long, solid, cylindrical wire of radius $a = 12 \text{ mm}$ is in the direction of the central axis, and its magnitude varies linearly with radial distance r from the axis according to $J = \frac{J_0 r}{a}$, where $J_0 = \frac{10^5}{4\pi} \text{ A/m}^2$. Find the magnitude of the magnetic field at $r = \frac{a}{2}$ in μT .
- The below figure shows two closed paths wrapped around two conducting loops carrying currents $i_1 = 5.0 \text{ A}$ and $i_2 = 3.0 \text{ A}$. What is the value of the integral $\oint \vec{B} \cdot d\vec{s}$ for (a) path 1 and (b) path 2?

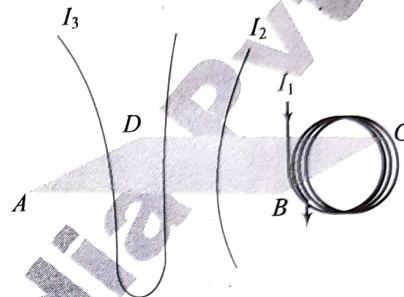


- Each of the eight conductors in the below figure carries 2.0 A of current into or out of the page. Two paths are indicated for the line integral $\oint \vec{B} \cdot d\vec{s}$. What is the value of the integral for (a) path 1 and (b) path 2?

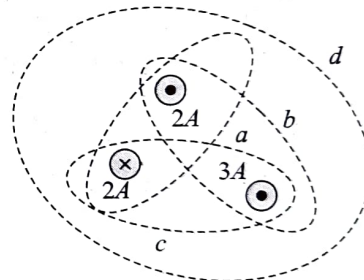


Single Correct Answer Type

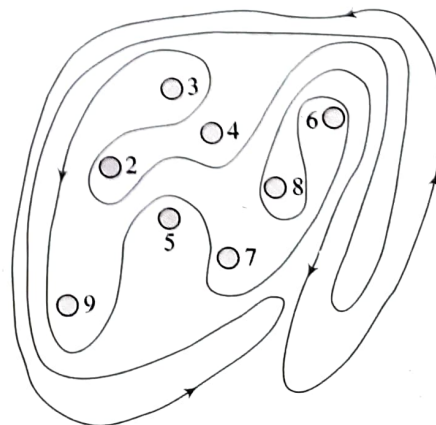
- Three distinct current carrying wires intersect a finite rectangular plane ABCD. The current in left wire and the loop is I_1 . The direction of current in left most wire and right most loop is downwards as shown in the figure. The current I_2 through middle wire is adjusted so that the path integral of the total magnetic field along the perimeter of the rectangle is zero, that is, $\oint_{ABCD} \vec{B} \cdot d\vec{l} = 0$. Then the current I_2 is



- $2I_1$ and upwards
 - $2I_1$ and downwards
 - $4I_1$ and upwards
 - $3I_1$ and downwards
- Rank the value of $\oint \vec{B} \cdot d\vec{l}$ for the closed paths shown in figure from the smallest to largest.

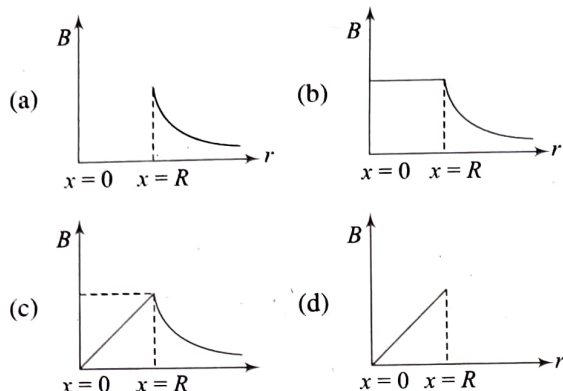


- a, b, c, d
 - a, c, d, b
 - a, d, c, b
 - a, c, b, d
- Eight wires cut the page perpendicularly at the points shown in figure. A wire labeled with the integer k ($k = 1, 2, \dots, 8$) carries the current ki , where $i = 2 \text{ A}$. For those wires with odd k , the current is out of the page; for those with even k , it is into the page. The value of $\oint \vec{B} \cdot d\vec{s}$ along the closed path indicated and in the direction shown.

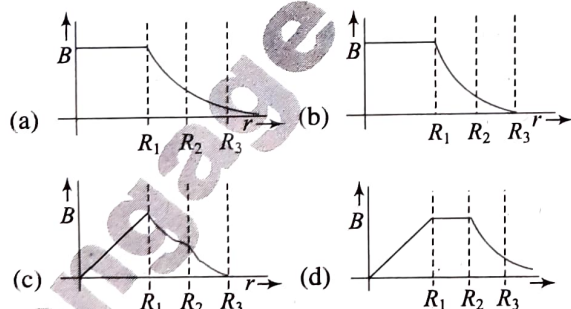
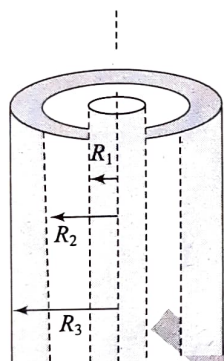


- (a) $10 \mu_0$ (b) $5 \mu_0$
(c) $15 \mu_0$ (d) $20 \mu_0$

7. A long thin hollow metallic cylinder of radius ' R ' has a current i ampere. The magnetic induction ' B ' away from the axis at a distance r from the axis varies as shown in

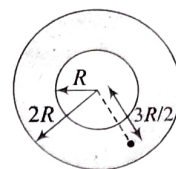


8. A coaxial cable is made up of two conductors. The inner conductor is solid and is of radius R_1 and the outer conductor is hollow of inner radius R_2 and outer radius R_3 . The space between the conductors is filled with air. The inner and outer conductors are carrying currents of equal magnitudes and in opposite directions. Then the variation of magnetic field with distance from the axis is best plotted as:



9. Figure shows the cross-sectional view of the hollow cylindrical conductor with inner radius ' R ' and outer radius ' $2R$ ', cylinder carrying uniformly distributed current along its axis. The magnetic induction at point ' P ' at a distance $\frac{3R}{2}$ from the axis of the cylinder will be

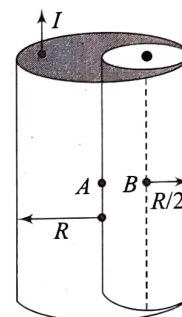
- (a) Zero
(b) $\frac{5\mu_0 i}{72\pi R}$
(c) $\frac{7\mu_0 i}{18\pi R}$
(d) $\frac{5\mu_0 i}{36\pi R}$



10. A current i ampere flows along the inner conductor of a coaxial cable and returns along the outer conductor of the cable, then the magnetic induction at any point outside the conductor at a distance r metre from the axis is

- (a) ∞ (b) Zero
(c) $\frac{\mu_0 2i}{4\pi r}$ (d) $\frac{\mu_0 2\pi i}{4\pi r}$

11. From a cylinder of radius R , a cylinder of radius $R/2$ is removed, as shown. Current flowing in the remaining cylinder is I . Magnetic field strength is:



- (a) zero at point A (b) zero at point B
(c) $\frac{\mu_0 I}{3\pi R}$ at point A (d) $\frac{\mu_0 I}{3\pi R}$ at point B

12. A winding wire which is used to frame a solenoid can bear a maximum 10 A current. If length of solenoid is 80 cm and its cross sectional radius is 3 cm, then required length of winding wire is ($B = 0.2$ T)

- (a) 1.2×10^2 m (b) 4.8×10^2 m
(c) 2.4×10^3 m (d) 6×10^3 m

13. A cylindrical conductor of radius ' R ' carries a current ' i '. The value of magnetic field at a point which is $R/4$ distance inside from the surface is 10 T. Find the value of magnetic field at point which is $4R$ distance outside from the surface

- (a) $\frac{4}{3}$ T (b) $\frac{8}{3}$ T
(c) $\frac{40}{3}$ T (d) $\frac{80}{3}$ T

Multiple Correct Answers Type

14. Two coaxial solenoids 1 and 2 of the same length are set so that one is inside the other. The number of turns per unit length are n_1 and n_2 . The currents i_1 and i_2 are flowing in

2.12 Magnetism and Electromagnetic Induction

opposite directions. The magnetic field inside the inner coil is zero. This is possible when

- (a) $i_1 \neq i_2$ and $n_1 = n_2$ (b) $i_1 = i_2$ and $n_1 \neq n_2$
(c) $i_1 = i_2$ and $n_1 = n_2$ (d) $i_1 n_1$ and $i_2 n_2$
15. Two identical current carrying coaxial loops, carry current I in an opposite sense. A simple amperian loop passes through both of them once. Calling the loop as C ,

- (a) $\oint B \cdot dl = \mu_0 I$
(b) the value of $\oint B \cdot dl = \pm 2\mu_0 I$ is independent of sense of C
(c) there may be a point on C where, $\mathbf{B}$ and $d\mathbf{l}$ are perpendicular
(d) B vanishes everywhere on C

Answers Key

Subjective Type

1. 10
2. (a) -2.5×10^{-6} T.m.
(b) -1.6×10^{-5} T.m.
3. (a) -2.5×10^{-6} T.m
(b) The value of $\oint \vec{B} \cdot d\vec{s}$ depends only on the current enclosed, and not the shape of the Amperian loop.

Single Correct Answer Type

4. (c) 5. (b) 6. (a) 7. (a) 8. (c)
9. (d) 10. (b) 11. (d) 12. (c) 13. (b)

Multiple Correct Answers Type

14. (c, d) 15. (b, c)

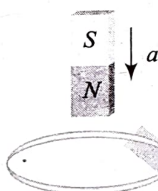
Electromagnetic Induction

DPP 3.1

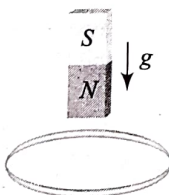
Magnetic Flux, Faraday's and Lenz's Law 1

Single Correct Answer Type

1. A metallic ring is attached with the wall of a room. When the north pole of a magnet is brought near to it, the induced current in the ring will be



- (a) First clockwise, then anticlockwise
 (b) In clockwise direction
 (c) In anticlockwise direction
 (d) First anticlockwise, then clockwise
2. A copper ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet while it is passing through the ring is

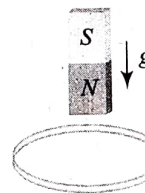


- (a) Equal to that due to gravity
 (b) Less than that due to gravity

- (c) More than that due to gravity
 (d) Depends on the diameter of the ring and the length of the magnet

3. A copper ring as shown in the figure is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet while it is passing through the ring is

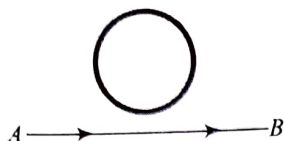
- (a) Equal to that due to gravity
 (b) Less than that due to gravity
 (c) More than that due to gravity
 (d) Depends on the diameter of the ring and the length of the magnet



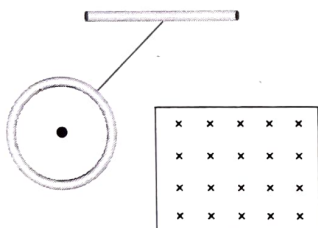
4. A magnet is dropped down an infinitely long vertical copper tube
- (a) The magnet moves with continuously increasing velocity and ultimately acquires a constant terminal velocity
 (b) The magnet moves with continuously decreasing velocity and ultimately comes to rest
 (c) The magnet moves with continuously increasing velocity but constant acceleration
 (d) The magnet moves with continuously increasing velocity and acceleration

3.2 Magnetism and Electromagnetic Induction

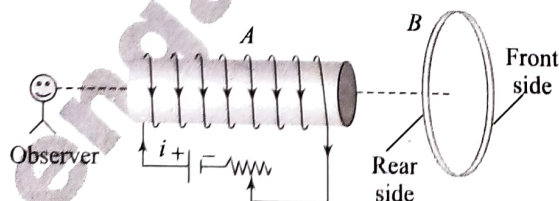
5. An electron moves along the line AB , which lies in the same plane as a circular loop of conducting wires as shown in the diagram. What will be the direction of current induced if any, in the loop?



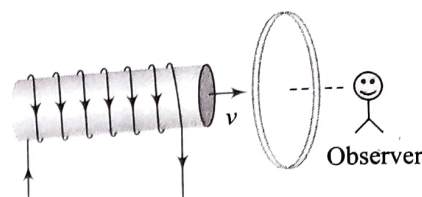
- (a) No current will be induced
(b) The current will be clockwise
(c) The current will be anticlockwise
(d) The current will change direction as the electron passes by
6. The current flowing in two coaxial coils in the same direction. On increasing the distance between the two, the electric current will
- (a) Increase
(b) Decrease
(c) Remain unchanged
(d) The information is incomplete
7. A metallic ring connected to a rod oscillates freely like a pendulum. If now a magnetic field is applied in horizontal direction so that the pendulum now swings through the field, the pendulum will



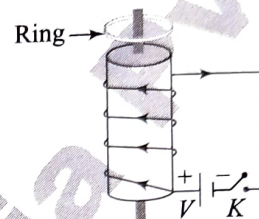
- (a) keep oscillating with the old time period
(b) keep oscillating with a smaller time period
(c) keep oscillating with a larger time period
(d) come to rest very soon
8. An aluminum ring B faces an electromagnet A . The current I through A can be altered
- (a) Whether I increases or decreases, B will not experience any force
(b) If I decrease, A will repel B
(c) If I increases, A will attract B
(d) If I increases, A will repel B



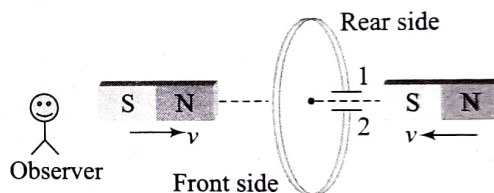
9. A current carrying solenoid is approaching a conducting loop as shown in the figure. The direction of induced current as observed by an observer on the other side of the loop will be



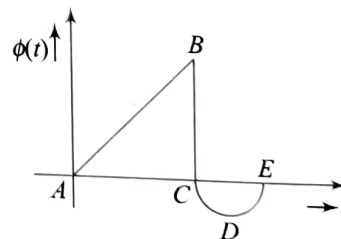
- (a) Anticlockwise
(b) Clockwise
(c) East
(d) West
10. A conducting ring is placed around the core of an electromagnet as shown in the figure. When key K is pressed, the ring



- (a) Remain stationary
(b) Is attracted towards the electromagnet
(c) Jumps out of the core
(d) None of the above
11. The north and south poles of two identical magnets approach a coil, containing a condenser, with equal speeds from opposite sides. Then

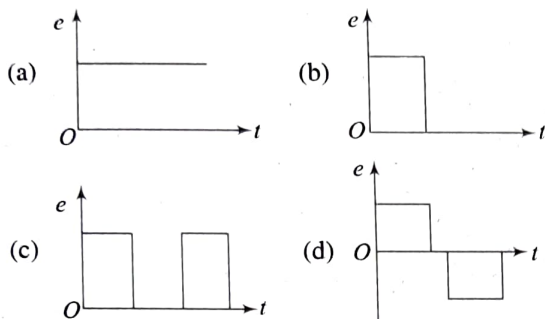
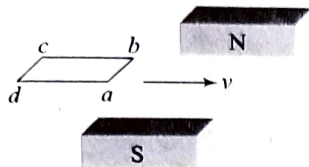


- (a) Plate 1 will be negative and plate 2 positive
(b) Plate 1 will be positive and plate 2 negative
(c) Both the plates will be positive
(d) Both the plates will be negative
12. The graph shows the variation in magnetic flux $\phi(t)$ with time through a coil. Which of the statements given below is not correct?

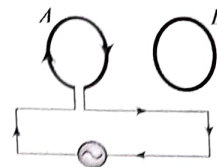


- (a) There is a change in the direction as well as magnitude of the induced emf between B and D
(b) The magnitude of the induced emf is maximum between B and C
(c) There is a change in the direction as well as magnitude of induced emf between A and C
(d) The induced emf is zero at B

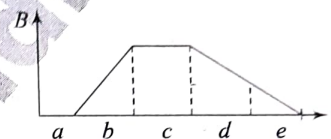
13. A horizontal loop $abcd$ is moved across the pole pieces of a magnet as shown in the figure, with a constant speed v . When the edge ab of the loop enters the pole pieces at time $t = 0$ sec. Which one of the following graphs represents correctly the induced emf in the coil?



14. Two circular coils A and B are facing each other as shown in figure. The current i through A can be altered



- (a) There will be repulsion between A and B if i is increased
 (b) There will be attraction between A and B if i is increased
 (c) There will be neither attraction nor repulsion when i is changed
 (d) Attraction or repulsion between A and B depends on the direction of current. It does not depend whether the current is increased or decreased
15. The graph gives the magnitude $B(t)$ of a uniform magnetic field that exists throughout a conducting loop, perpendicular to the plane of the loop. Rank the five regions of the graph according to the magnitude of the emf induced in the loop, greatest first



- (a) $b > (d=e) < (a=c)$ (b) $b > (d=e) > (a=c)$
 (c) $b < d < e < c < a$ (d) $b > (a=c) > (d=e)$

Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (a) 4. (a) 5. (d)

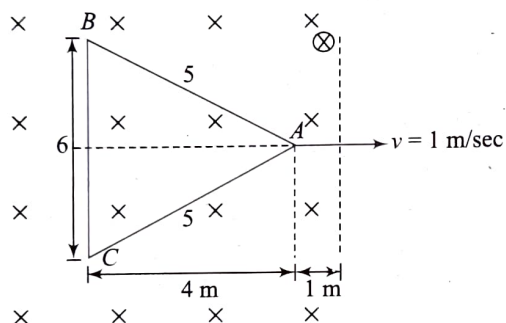
6. (a) 7. (d) 8. (d) 9. (b) 10. (c)
 11. (b) 12. (d) 13. (d) 14. (a) 15. (b)

DPP 3.2

Magnetic Flux, Faraday's and Lenz's Law 2

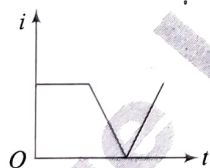
Subjective Type

1. An isosceles rigid triangle ABC of sides 6 m, 5 m, and 5 m is lying in a uniform magnetic field $\vec{B} = 1T$, directed perpendicular to plane of the loop as shown in the figure. The loop is pulled out at constant velocity $v = 1 \text{ m/sec}$ as shown in the figure. Initially vertex A is at distance 1 m from boundary of magnetic field. Draw the graph of induced e.m.f. in the loop as a function of time.

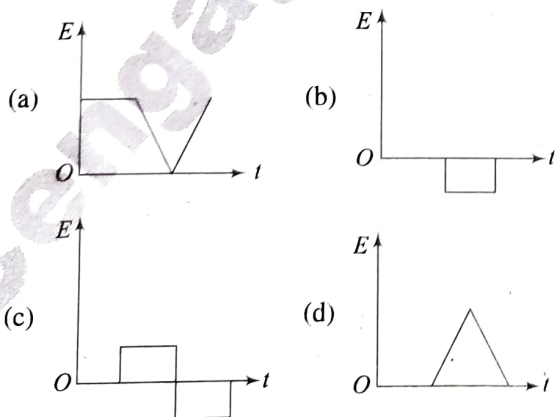


Single Correct Answer Type

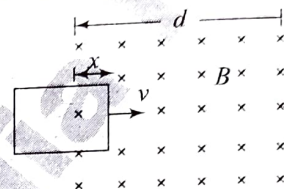
2. The current i in an induction coil varies with time t according to the graph shown



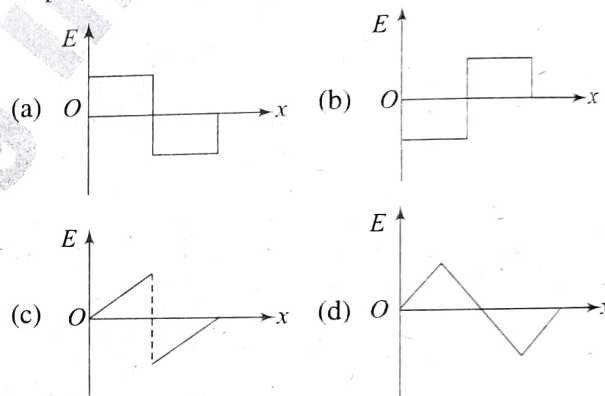
in figure. Which of the following graphs shows the induced emf (e) in the coil with time?



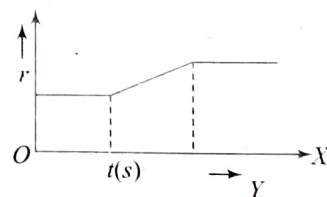
3. A rectangular loop is being pulled at a constant speed v , through a region of certain thickness d , in which a uniform magnetic field B is set up.



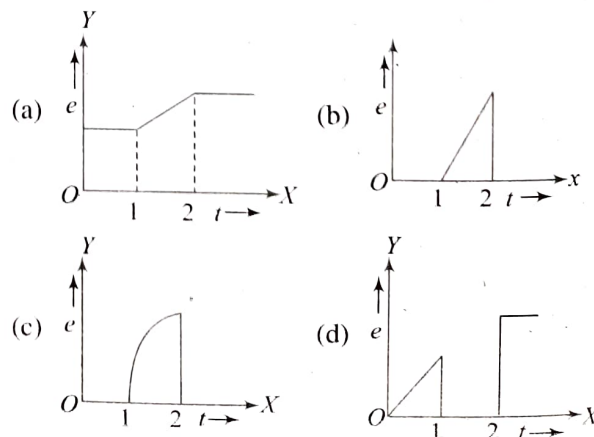
The graph between position x of the right hand edge of the loop and the induced emf E will be



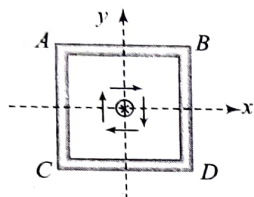
4. A flexible wire bent in the form of a circle is placed in a uniform magnetic field perpendicular to the plane of the coil. The radius of the coil changes as shown in the figure.



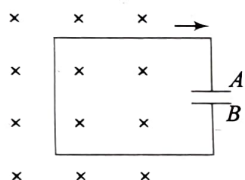
The graph of induced emf in the coil is represented by



5. A circular coil and a bar magnet placed nearby are made to move in the same direction. The coil covers a distance of 1 m in 0.5 sec and the magnet a distance of 2 m in 1 sec. The induced emf produced in the coil
- Zero
 - 1 V
 - 0.5 V
 - Cannot be determined from the given information
6. A square coil ABCD lying in x - y plane with its centre at origin. A long straight wire passing through origin carries a current $i = 2t$ in negative z -direction. The induced current in the coil is



- Clockwise
 - Anticlockwise
 - Alternating
 - Zero
7. A conducting loop having a capacitor is moving outward from the magnetic field then which plate of the capacitor will be positive



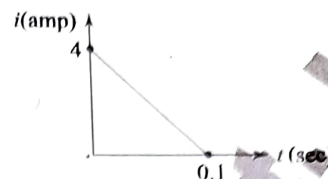
- Plate A
 - Plate B
 - Plate A and Plate B both
 - None
8. A small coil is introduced between the poles of an electromagnet so that its axis coincides with the magnetic field direction. The number of turns is n and the cross sectional area of the coil is A . When the coil turns through 180° about its diameter, the charge flowing through the coil is Q . The total resistance of the circuit is R . What is the magnitude of the magnetic induction?

- $\frac{QR}{nA}$
- $\frac{2QR}{nA}$
- $\frac{Qn}{2RA}$
- $\frac{QR}{2nA}$

9. A hundred turns of insulated copper wire are wrapped around an iron cylinder of area $1 \times 10^{-3} \text{ m}^2$ and are connected to a resistor. The total resistance in the circuit is 10 ohms. If the longitudinal magnetic induction in the iron changes from 1 weber m^{-2} , in one direction to 1 Weber m^{-2} in the opposite direction, how much charge flows through the circuit.

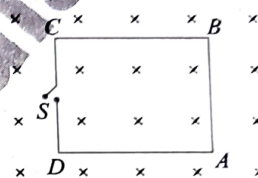
- $2 \times 10^{-2} \text{ C}$
- $2 \times 10^{-3} \text{ C}$
- $2 \times 10^{-4} \text{ C}$
- $2 \times 10^{-5} \text{ C}$

10. Some magnetic flux is changed from a coil of resistance 10 ohm. As a result an induced current is developed in it, which varies with time as shown in figure. The magnitude of change in flux through the coil in webers is



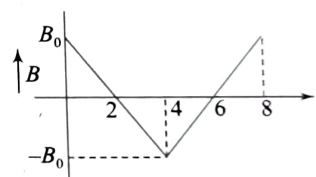
- 2
- 4
- 6
- None of these

11. The magnetic field in the cylindrical region shown in the figure increases at a constant rate of 20 mT/sec . Each side of the square loop ABCD has a length of 1 cm and resistance of 4Ω . Find the current in the wire AB if the switch S is closed



- $1.25 \times 10^{-7} \text{ A}$ (anticlockwise)
- $1.25 \times 10^{-7} \text{ A}$ (clockwise)
- $2.5 \times 10^{-7} \text{ A}$ (anticlockwise)
- $2.5 \times 10^{-7} \text{ A}$ (clockwise)

12. In the graph variation of magnetic field with time ' t ' applied perpendicular to the plane of the ring is shown:



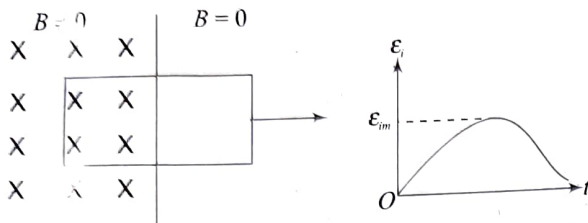
- at $t = 2 \text{ sec}$ and current flowing in ring is equal to zero
- current will change its direction two times in time intervals $t = 0$ to $t = 8 \text{ sec}$
- current will change its direction only once in the above interval
- flux in ring is same at $t = 0$ and $t = 4 \text{ sec}$

Multiple Correct Answers Type

13. A conducting loop rotates with constant angular velocity about its fixed diameter in a uniform magnetic field whose direction is perpendicular to that fixed diameter.
- The emf will be maximum at the moment when flux is zero.
 - The emf will be '0' at the moment when flux is maximum.
 - The emf will be maximum at the moment when plane of the loop is parallel to the magnetic field
 - The phase difference between the flux and the emf is $\pi/2$.

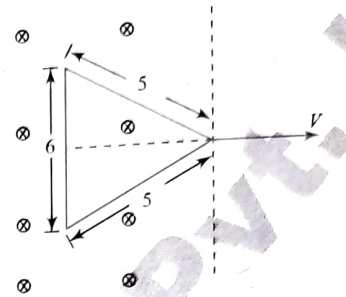
3.6 Magnetism and Electromagnetic Induction

14. Plane rectangular loop is placed in a magnetic field. The emf induced in the loop due to this field is ϵ_i whose maximum value is ϵ_{im} . The loop was pulled out of the magnetic field at a variable velocity. Assume the $\vec{B}$ is uniform and constant. ϵ_i is plotted against time t as shown in the graph. Which of the following are/is correct statement(s):



- ϵ_{im} is independent of rate of removal of coil from the field.
- The total charge that passes through any point of the loop in the process of complete removal of the loop does not depend on velocity of removal.
- The total area under the curve (ϵ_i vs t) is independent of rate of removal of coil from the field.
- The area under the curve is dependent on the rate of removal of the coil.

15. A triangular loop as shown in the figure is started to being pulled out at $t = 0$ from a uniform magnetic field with a constant velocity v . Total resistance of the loop is constant and equals to R . Then the variation of power produced in the loop with time will be:



- power produced in the loop increasing linearly with time till whole loop comes out
- power produced in the loop increases parabolically till whole loop comes out
- current in the loop increases linearly with time till whole loop comes out
- power produced in the loop will be constant with time

Answers Key

Single Correct Answer Type

2. (c) 3. (b) 4. (b) 5. (a) 6. (d)
7. (a) 8. (d) 9. (a) 10. (a) 11. (a)
12. (c)

Multiple Correct Answers Type

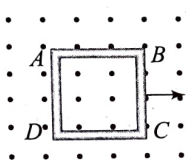
13. (a, b, d) 14. (b, c) 15. (b, c)

DPP 3.3

Motional E.M.F 1

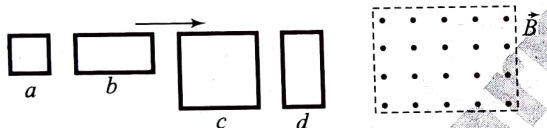
Single Correct Answer Type

1. A metallic square loop $ABCD$ is moving in its own plane with velocity v in a uniform magnetic field perpendicular to its plane as shown in the figure. An electric field is induced

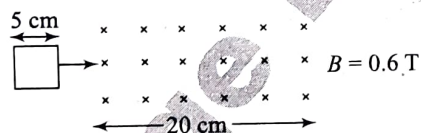


- (a) In AD , but not in BC
 (b) In BC , but not in AD
 (c) Neither in AD nor in BC
 (d) In both AD and BC

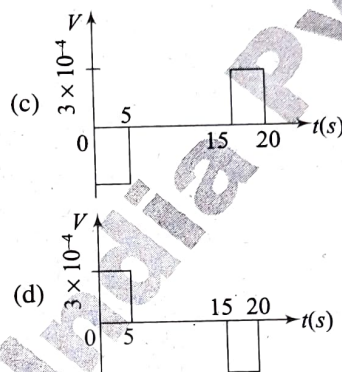
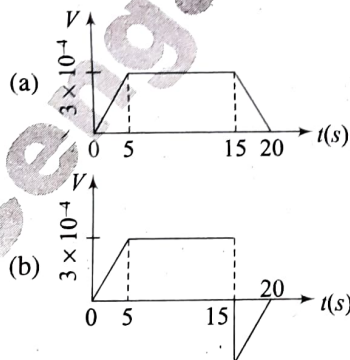
2. The figure shows four wire loops, with edge lengths of either L or $2L$. All four loops will move through a region of uniform magnetic field $\vec{B}$ (directed out of the page) at the same constant velocity. Rank the four loops according to the maximum magnitude of the e.m.f. induced as they move through the field, greatest first



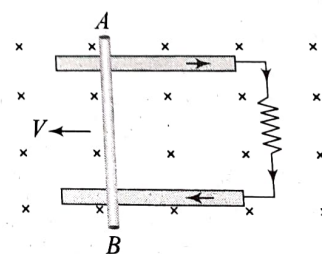
- (a) $(e_c = e_d) < (e_a = e_b)$ (b) $(e_c = e_d) > (e_a = e_b)$
 (c) $e_c > e_d > e_b > e_a$ (d) $e_c < e_d < e_b < e_a$
3. A square loop of side 5 cm enters a magnetic field with 1 cm s^{-1} .



The front edge enters the magnetic field at $t = 0$ then which graph best depicts emf

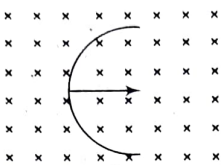


4. A player with 3 m long iron rod runs towards east with a speed of 30 km/hr. Horizontal component of earth's magnetic field is $4 \times 10^{-5} \text{ Wb/m}^2$. If he is running with rod in horizontal and vertical positions, then the potential difference induced between the two ends of the rod in two cases will be
- (a) Zero in vertical position and $1 \times 10^{-3} \text{ V}$ in horizontal position
 (b) $1 \times 10^{-3} \text{ V}$ in vertical position and zero in horizontal position
 (c) Zero in both cases
 (d) $1 \times 10^{-3} \text{ V}$ in both cases
5. At a place the value of horizontal component of the earth's magnetic field H is $3 \times 10^{-5} \text{ Weber/m}^2$. A metallic rod AB of length 2 m placed in east-west direction, having the end A towards east, falls vertically downward with a constant velocity of 50 m/s. Which end of the rod becomes positively charged and what is the value of induced potential difference between the two ends?
- (a) End A , $3 \times 10^{-3} \text{ mV}$ (b) End A , 3 mV
 (c) End B , $3 \times 10^{-3} \text{ mV}$ (d) End B , 3 mV
6. Consider the situation shown in the figure. The wire AB is sliding on the fixed rails with a constant velocity. If the wire AB is replaced by semicircular wire, the magnitude of the induced current will



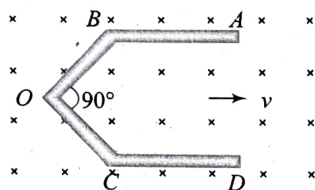
3.8 Magnetism and Electromagnetic Induction

- (a) Increase
(b) Remain the same
(c) Decrease
(d) Increase or decrease depending on whether the semicircle bulges towards the resistance or away from it
7. A straight wire of length L is bent into a semicircle. It is moved in a uniform magnetic field with speed v with diameter perpendicular to the field. The induced emf between the ends of the wire is



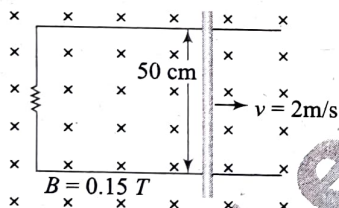
- (a) BLv (b) $2BLv$ (c) $2\pi BLv$ (d) $\frac{2BvL}{\pi}$

8. A conductor $ABOCD$ moves along its bisector with a velocity of 1 m/s through a perpendicular magnetic field of 1 wb/m^2 , as shown in the figure. If all the four sides are of 1 m length each, then the induced emf between points A and D is



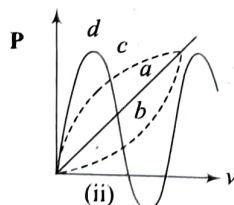
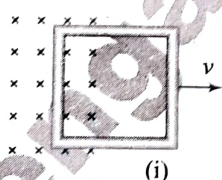
- (a) 0 (b) 1.41 volt
(c) 0.71 volt (d) None of the above

9. As shown in the figure a metal rod makes contact and complete the circuit. The circuit is perpendicular to the magnetic field with $B = 0.15 \text{ tesla}$. If the resistance is 3Ω , force needed to move the rod as indicated with a constant speed of 2 m/sec is



- (a) $3.75 \times 10^{-3} \text{ N}$ (b) $3.75 \times 10^{-2} \text{ N}$
(c) $3.75 \times 10^2 \text{ N}$ (d) $3.75 \times 10^{-4} \text{ N}$

10. Figure (i) shows a conducting loop being pulled out of a magnetic field with a speed v . Which of the four plots shown in Figure (ii) may represent the power delivered by the pulling agent as a function of the speed v ?

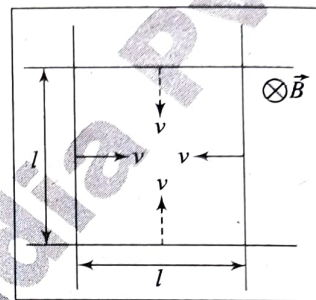


- (a) a (b) b (c) c (d) d

Comprehension Type

For Q. 11 to 15

In the figure shown the four rods have λ resistance per unit length. The arrangement is kept in a magnetic field of constant magnitude B and directed perpendicular to the plane of the figure and direction inwards. Initially the sides as shown form a square. Now each wire starts moving with constant velocity v towards opposite wire. Find as a function of time:



11. Induced emf. in the circuit.

- (a) $4Bv(l - 2vt)$ (b) $Bv(l - 2vt)$
(c) $4Bv(l + 2vt)$ (d) zero

12. Induced current in the circuit with direction.

- (a) $\frac{2Bv}{\lambda}$ (b) $\frac{Bv}{\lambda}$ (c) $\frac{Bv}{2\lambda}$ (d) zero

13. Force required on each wire to keep its velocity constant.

- (a) $\frac{B^2v}{\lambda}(l + 2vt)$ (b) $\frac{B^2v}{\lambda}(l - vt)$
(c) zero (d) $\frac{B^2v}{\lambda}(l - 2vt)$

14. Total power required to maintain constant velocity.

- (a) $\frac{4B^2v^2}{\lambda}(l + 2vt)$ (b) $\frac{4B^2v^2}{\lambda}(l - vt)$
(c) $\frac{4B^2v^2}{\lambda}(l - 2vt)$ (d) $\frac{B^2v^2}{\lambda}(l - 2vt)$

15. Thermal power developed in the circuit.

- (a) $\frac{4B^2v^2}{\lambda}(l - 2vt)$ (b) $\frac{4B^2v^2}{\lambda}(l - vt)$
(c) $\frac{4B^2v^2}{\lambda}(l + 2vt)$ (d) $\frac{B^2v^2}{\lambda}(l - 2vt)$

Answers Key

Single Correct Answer Type

1. (d) 2. (b) 3. (c) 4. (b) 5. (b)
6. (b) 7. (d) 8. (b) 9. (a) 10. (b)

Comprehension Type

11. (a) 12. (b) 13. (d) 14. (c) 15. (a)

DPP 3.4

Motional E.M.F 2

Single Correct Answer Type

1. A copper rod of length l is rotated about one end perpendicular to the magnetic field B with constant angular velocity ω . The induced e.m.f. between the two ends is

(a) $\frac{1}{2}B\omega l^2$ (b) $\frac{3}{4}B\omega l^2$
(c) $B\omega l^2$ (d) $2B\omega l^2$

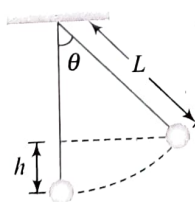
2. A conducting rod of length $2l$ is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field $\vec{B}$ exists parallel to the axis of rotation. The e.m.f. induced between two ends of the rod is

(a) $B\omega l^2$ (b) $\frac{1}{2}B\omega l^2$
(c) $\frac{1}{8}B\omega l^2$ (d) Zero

3. A conducting rod AC of length $4l$ is rotated about a point O in a uniform magnetic field $\vec{B}$ directed into the paper. $AO = l$ and $OC = 3l$. Then

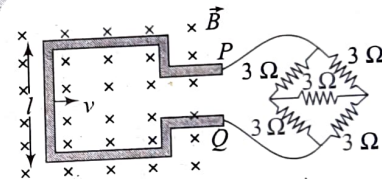
(a) $V_A - V_O = \frac{B\omega l^2}{2}$ (b) $V_O - V_C = \frac{7}{2}B\omega l^2$
(c) $V_A - V_C = 4B\omega l^2$ (d) $V_C - V_O = \frac{9}{2}B\omega l^2$

4. A simple pendulum with bob of mass m and conducting wire of length L swings under gravity through an angle 2θ . The earth's magnetic field component in the direction perpendicular to swing is B . Maximum potential difference induced across the pendulum is



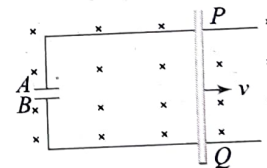
(a) $2BL \sin\left(\frac{\theta}{2}\right)(gL)^{1/2}$ (b) $BL \sin\left(\frac{\theta}{2}\right)(gL)$
(c) $BL \sin\left(\frac{\theta}{2}\right)(gL)^{3/2}$ (d) $BL \sin\left(\frac{\theta}{2}\right)(gL)^2$

5. A square metallic wire loop of side 0.1 m and resistance of 1Ω is moved with a constant velocity in a magnetic field of 2 wb/m^2 as shown in the figure. The magnetic field is perpendicular to the plane of the loop, loop is connected to a network of resistances. What should be the velocity of loop so as to have a steady current of 1 mA in loop?



(a) 1 cm/sec (b) 2 cm/sec
(c) 3 cm/sec (d) 4 cm/sec

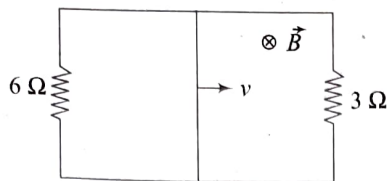
6. A conducting rod PQ of length $L = 1.0$ m is moving with a uniform speed $v = 2 \text{ m/s}$ in a uniform magnetic field $B = 4.0 \text{ T}$ directed into the paper. A capacitor of capacity $C = 10 \mu\text{F}$ is connected as shown in the figure. Then



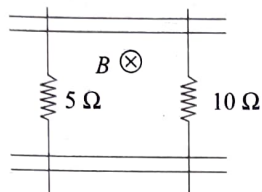
(a) $q_A = +80 \mu\text{C}$ and $q_B = -80 \mu\text{C}$
(b) $q_A = -80 \mu\text{C}$ and $q_B = +80 \mu\text{C}$
(c) $q_A = 0 = q_B$
(d) Charge stored in the capacitor increases exponentially with time

7. A rectangular loop with a sliding connector of length $l = 1.0$ m is situated in a uniform magnetic field $B = 2 \text{ T}$ perpendicular to the plane of loop. Resistance of connector is $r = 2 \Omega$. Two resistances of 6Ω and 3Ω are connected as shown in the figure. The external force required to keep the connector moving with a constant velocity $v = 2 \text{ m/s}$ is

3.10 Magnetism and Electromagnetic Induction



- (a) 6 N (b) 4 N (c) 2 N (d) 1 N
8. A pair of parallel conducting rails lie at right angle to a uniform magnetic field of 2.0 T as shown in the figure. Two resistors 10 Ω and 5 Ω are to slide without friction along the rail. The distance between the conducting rails is 0.1 m. Then

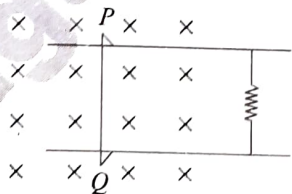


- (a) Induced current = $\frac{1}{150}$ A directed clockwise if 10 Ω resistor is pulled to the right with speed 0.5 ms^{-1} and 5 Ω resistor is held fixed
- (b) Induced current $\frac{1}{300}$ A directed anticlockwise if 10 Ω resistor is pulled to the right with speed 0.5 ms^{-1} and 5 Ω resistor is held fixed
- (c) Induced current $\frac{1}{300}$ A directed clockwise if 5 Ω resistor is pulled to the left at 0.5 ms^{-1} and 10 Ω resistor is held at rest
- (d) Induced current $\frac{1}{150}$ A directed anticlockwise if 5 Ω resistor is pulled to the left at 0.5 ms^{-1} and 10 Ω resistor is held at rest.

Comprehension Type

For Q. 9 to 12

Consider the situation shown in figure. The wire PQ has mass m , resistance r and can slide on the smooth, horizontal parallel rails separated by a distance l . The resistance of the rails is negligible. A uniform magnetic field B exists in the rectangular region and a resistance R connects the rails outside the field region.



At $t=0$, the wire PQ is pushed towards right with a speed v_0 . Find

9. the current in the loop at an instant when the speed of the wire PQ is v

- (a) $\frac{Blv}{r+R}$ (b) $\frac{2Blv}{r+R}$
- (c) $\frac{Blv}{2(r+R)}$ (d) None of these

10. the acceleration of the wire at this instant.

- (a) $\frac{2B^2l^2v}{m(R+r)}$ towards left
- (b) $\frac{B^2l^2v}{m(R+r)}$ towards right
- (c) $\frac{B^2l^2v}{m(R+r)}$ towards left
- (d) None of these

11. the velocity v as a function of x .

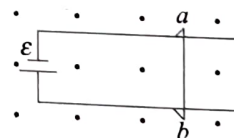
- (a) $v = v_0 - \frac{2B^2l^2x}{m(R+r)}$ (b) $v = v_0 - \frac{B^2l^2x}{m(R+r)}$
- (c) $v = v_0 - \frac{B^2l^2x}{2m(R+r)}$ (d) None of these

12. the maximum distance the wire will move.

- (a) $\frac{2mv_0(R+r)}{B^2l^2}$ (b) $\frac{mv_0(R+r)}{2B^2l^2}$
- (c) $\frac{mv_0(R+r)}{B^2l^2}$ (d) None of these

For Q. 13 to 15

Figure shows smooth pair of thick metallic rails connected across a battery of emf $\mathcal{E}$ having a negligible internal resistance. A wire ab of length l and resistance r can slide smoothly on the rails. The entire system lies in a horizontal plane and is immersed in a uniform vertical magnetic field B . At an instant t , the wire is given a small velocity v towards right.



13. Find the current in it at this instant. What is the direction of the current?

- (a) $\frac{1}{r}(E - vBl)$, from b to a
- (b) $\frac{1}{r}(E - vBl)$, from a to b
- (c) $\frac{1}{2r}(E - vBl)$, from b to a
- (d) None of these

14. What is the force acting on the wire at this instant?

- (a) $\frac{IB}{r}(E - vBl)$ towards left
 (b) $\frac{IB}{r}(E - vBl)$ towards right
 (c) $\frac{IB}{2r}(E - vBl)$ towards right
 (d) None of these

15. After some time the wire ab will slide with a constant velocity. Find the velocity.

- (a) $\frac{2E}{Bl}$
 (b) $\frac{E}{2Bl}$
 (c) $\frac{E}{Bl}$
 (d) None of these

Answers Key

Single Correct Answer Type

1. (a) 2. (d) 3. (c) 4. (a) 5. (b)
 6. (a) 7. (c) 8. (d)

Comprehension Type

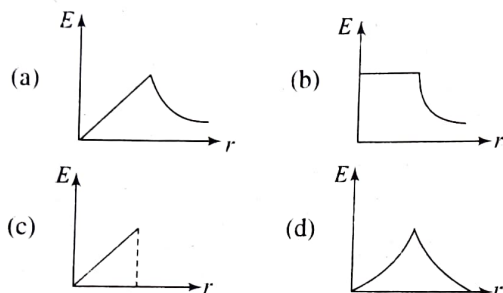
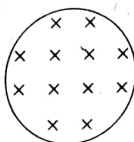
9. (a) 10. (c) 11. (b) 12. (c) 13. (a)
 14. (b) 15. (c)

DPP 3.5

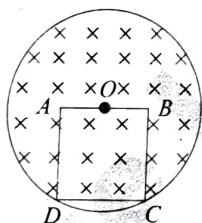
Induced Electric Field

Single Correct Answer Type

1. The magnetic field within cylindrical region whose cross-section is indicated starts increasing at a constant rate $\propto$ tesla/sec. The graph showing the variation of induced field with distance r from the axis of cylinder is:



2. A square non-conducting loop, 20 cm, on a side is placed in a magnetic field. The centre of side AB coincides with the centre of magnetic field. The magnetic field is increasing at the rate of 2 T/s. The potential difference between B and C is:



- (a) 30 mV (b) zero
(c) 10 mV (d) 20 mV
3. Refer to above question, the potential difference between C and D is:
- (a) 80 mV (b) zero
(c) 40 mV (d) 60 mV

Comprehension Type

For Q. 4 to 7

A thin non-conducting ring of mass m and radius a carrying a charge q can rotate freely about its own axis which is vertical. At the initial moment the ring was at rest in horizontal position and no magnetic field was present. At instant $t = 0$, a uniform

magnetic field is switched on which is vertically downward and increases with time according to the law $B = B_0 t$. Neglecting magnetism induced due to rotational motion of ring.

4. The magnitude of induced emf will be

- (a) $\pi a^2 B_0$ (b) $2a^2 B_0$
(c) zero (d) $\frac{1}{2} \pi a^2 B_0$

5. The magnitude of an electric field on the surface of the ring is

- (a) $a B_0$ (b) $2a B_0$
(c) $\frac{1}{2} a B_0$ (d) zero

6. Angular acceleration of ring is

- (a) $\frac{q B_0}{2m}$ (b) $\frac{q B_0}{4m}$
(c) $\frac{q B_0}{m}$ (d) $\frac{2q B_0}{m}$

7. Find instantaneous power developed by electric force acting on the ring at $t = 1$ sec.

- (a) $\frac{2q^2 B_0^2 a^2}{14m}$ (b) $\frac{q^2 B_0^2 a^2}{8m}$
(c) $\frac{3q^2 B_0^2 a^2}{m}$ (d) $\frac{q^2 B_0^2 a^2}{4m}$

For Q. 8 to 10

It is known to you that "whenever the flux of a magnetic field through the area bound by a closed conducting loop changes, an

emf is produced in the loop. Then emf is given by $\varepsilon = -\frac{d\phi}{dt}$, where

$\phi = \int \vec{B} \cdot d\vec{s}$ is the flux of the magnetic field through the area.

So whenever the magnetic flux through a closed loop changes, an electric current results. Let us now investigate "what is the external mechanism that maintains the electric field in the loop to drive the current". In other words what is the mechanism to produce an emf?

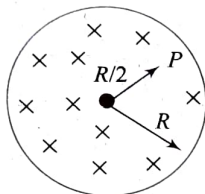
- (a) Keeping the magnetic field constant as time passes and moving whole or part of the loop.
(b) Keeping the loop at rest and changing the magnetic field.
(c) Combination of (a) and (b) that is by moving the loop (partly or wholly) as well as by changing the field. The mechanism (a) for production of emf is studied under the

heating motional emf and mechanism (b) under the heating induced electric field.

In mechanism (a), magnitude of the potential difference across the conductor is given by $\mathcal{E} = Blv$, where B , l , v have their usual meanings and the electrostatic field developed within the conductor $E = vB$.

Whereas if the magnetic field through a stationary conducting loop is changing with time, then also there will be an induced emf whose value will be $\mathcal{E} = \oint \vec{E} \cdot d\vec{l}$, where E is the induced electric field. The electric field produced by the changing magnetic field is non-electrostatic and non-conservative.

8. A uniform but time varying magnetic field $B = (2t^3 + 24t)$ T is present in a cylindrical region of radius $R = 2.5$ cm as shown in the figure. The force on an electron at P at $t = 2.0$ s is
- (a) 96×10^{-21} N
(b) 48×10^{-21} N



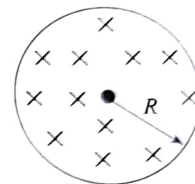
- (c) 24×10^{-21} N
(d) zero

9. If the above magnetic field is present perpendicular to a ring of radius of 1 cm, mass = 10 gram and charge = 1 C, then the angular velocity of the ring as a function of time is (the ring and the cylindrical region are coaxial)

- (a) $(6t^2 + 12) \times 10^2$ rad/s
(b) $(3t^2 + 24) \times 10^2$ rad/s
(c) $(t^2 + 12t) \times 10^2$ rad/s
(d) $(3t^2 + 4) \times 10^2$ rad/s

10. A magnetic field $B = 2t^3 - 24t$ is present perpendicular to plane of a disc of radius R as shown in the figure. The direction of induced electric field at $t = 2$ s is

- (a) clockwise
(b) anticlockwise
(c) no electric field is induced
(d) data insufficient



Answers Key

Single Correct Answer Type

1. (a) 2. (d) 3. (c)

Comprehension Type

4. (a) 5. (c) 6. (a) 7. (d) 8. (b)
9. (c) 10. (c)

DPP 4.1

Self- and Mutual Inductance

Subjective Type

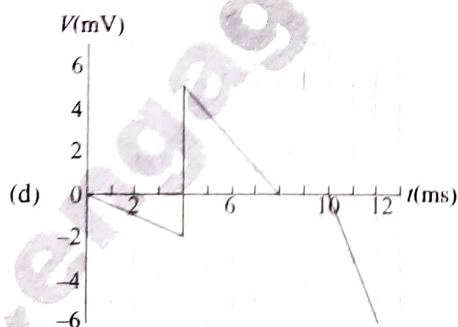
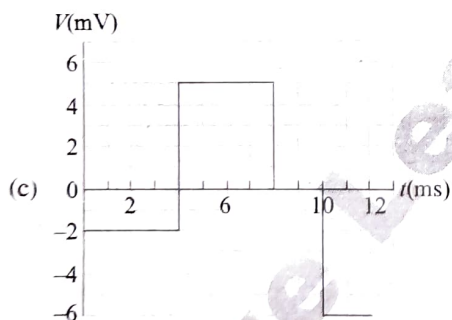
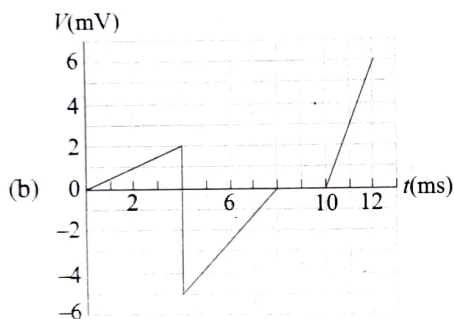
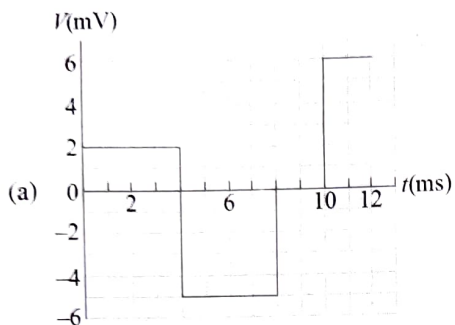
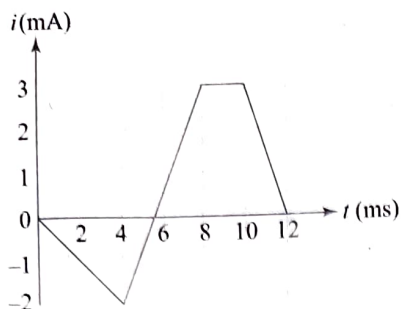
- Two solenoids A and B , spaced close to each other and sharing the same cylindrical axis, have 400 and 700 turns, respectively. A current of 3.50 A in solenoid A produces an average flux of $300 \mu\text{Wb}$ through each turn of A and a flux of $90.0 \mu\text{Wb}$ through each turn of B . (a) Calculate the mutual inductance of the two solenoids. (b) What is the inductance of A ? (c) What emf is induced in B when the current in A changes at the rate of 0.500 A/s ?
- Solenoid S_1 has N turns, radius R_1 , and length l . It is so long that its magnetic field is uniform nearly everywhere inside it and is nearly zero outside. Solenoid S_2 has N_2 turns, radius $R_2 < R_1$, and the same length as S_1 . It lies inside S_1 , with their axes parallel. (a) Assume S_1 carries variable current i . Compute the mutual inductance characterizing the emf induced in S_2 . (b) Now assume S_2 carries current i . Compute the mutual inductance to which the emf in S_1 is proportional. (c) State how the results of parts (a) and (b) compare with each other.

Single Correct Answer Type

- A 2.00-H inductor carries a steady current of 0.500 A. When the switch in the circuit is opened, the current is effectively zero after 10.0 ms. What is the average induced emf in the inductor during this time interval?

- 100 V
 - 150 V
 - 133 V
 - 200 V
- An emf of 25.0 mV is induced in a 500-turn coil when the current is changing at the rate of 10.0 A/s . What is the magnetic flux through each turn of the coil at an instant when the current is 4.00 A?
 - $20 \mu\text{T}\cdot\text{m}^2$
 - $10 \mu\text{T}\cdot\text{m}^2$
 - $15 \mu\text{T}\cdot\text{m}^2$
 - $30 \mu\text{T}\cdot\text{m}^2$
- The current in a coil changes from 3.50 A to 2.00 A in the same direction in 0.500 s. If the average emf induced in the coil is 12.0 mV, what is the inductance of the coil?
 - 2.00 mH
 - 4.00 mH
 - 3.00 mH
 - 8.00 mH
- A self-induced emf in a solenoid of inductance L changes in time as $\varepsilon = \varepsilon_0 e^{-kt}$. Assuming the charge is finite, find the total charge that passes a point in the wire of the solenoid.
 - $\frac{\varepsilon_0}{Lk^2}$
 - $\frac{2\varepsilon_0}{Lk^2}$
 - $\frac{\varepsilon_0}{2Lk^2}$
 - $\frac{3\varepsilon_0}{Lk^2}$
- The current in a 4.0 mH inductor varies in time as shown in the figure. The corresponding graph of the self induced emf across the inductor over the time interval $t = 0$ to $t = 12.0 \text{ ms}$ is

4.2 Magnetism and Electromagnetic Induction



8. An emf of 96.0 mV is induced in the windings of a coil when the current in a nearby coil is increasing at the rate of 1.20 A/s. The mutual inductance of the two coils is

- (a) 40 mH (b) 20 mH
(c) 10 mH (d) 80 mH

9. Two coils, held in fixed positions, have a mutual inductance of 100 μH . What is the peak emf in one coil when the current in the other coil is $i(t) = (10.0 \sin 1.00 \times 10^3 t)$, where i is in amperes and t is in seconds?

- (a) 2.00 V (b) 1.00 V
(c) 4.00 V (d) 3.00 V

10. Two single-turn circular loops of wire have radii R and r , with $R \gg r$. The loops lie in the same plane and are concentric. The mutual inductance of the pair is (approximately)

- (a) $\frac{\mu_0 \pi r^2}{R}$ (b) $\frac{2\mu_0 \pi r^2}{R}$
(c) $\frac{\mu_0 \pi r^2}{2R}$ (d) $\frac{3\mu_0 \pi r^2}{2R}$

Multiple Correct Answers Type

11. The current in a 90 mH inductor changes with time as $i = 1.0t^2 - 6.0t$, where i is in amperes and t is in seconds.

- (a) the magnitude of the induced emf at $t = 4.0$ s is 180 mV
(b) the emf zero at time $t = 3.0$ s
(c) the magnitude of the induced emf at $t = 4.0$ s is 360 mV
(d) the emf zero at time $t = 4.0$ s

Comprehension Type

For Q. 12 and 13

A solenoid of radius 2.50 cm has 400 turns and a length of 20.0 cm. The current in the coil is changing with time such that to produce an emf of 75.0 mV,

12. the inductance (L) of the solenoid is (approx.)

- (a) 4 mH (b) 5 mH
(c) 3 mH (d) 2 mH

13. the rate at which current must change through the solenoid is (approx)

- (a) 38.0 mA/s (b) 19.0 mA/s
(c) 21.0 mA/s (d) 50.0 mA/s

For Q. 14 and 15

A technician wraps wire around a tube of length $4\pi^2$ cm having a diameter of 8.00 cm. When the windings are evenly spread over the full length of the tube, the result is a solenoid containing 1000 turns of wire. If the current in this solenoid increases at the rate of 4.00 A/s,

14. the inductance of this solenoid is

- (a) 32 mH (b) 16 mH
(c) 48 mH (d) 8 mH

15. the self-induced emf in the solenoid is

- (a) 32 mV (b) 16 mV
(c) 64 mV (d) 24 mV

Answers Key

Subjective Type

1. (a) 18.0 mH (b) 34.3 mH (c) 9.00 mV

2. (a) $M_{12} = \frac{\mu_0 \pi R_2^2 N_1 N_2}{l}$

(b) $M_{12} = \frac{\mu_0 \pi R_2^2 N_1 N_2}{l}$

(c) They are the same.

Single Correct Answer Type3. (a) 4. (a) 5. (b) 6. (a) 7. (a)
8. (d) 9. (b) 10. (c)**Multiple Correct Answers Type**

11. (a,b)

Comprehension Type

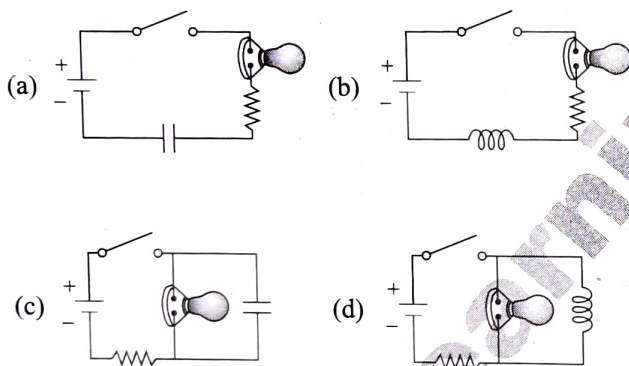
12. (d) 13. (a) 14. (b) 15. (c)

Cengage Learning India

Inductance and L-R Circuits

Concept Based

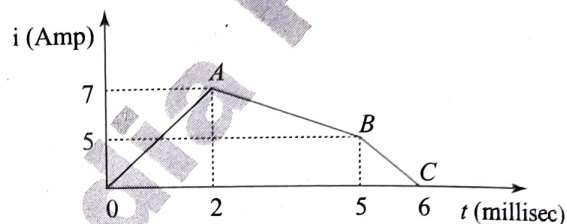
1. Consider the four circuits shown in the figure, each consisting of a battery, a switch, a light bulb, a resistor, and either a capacitor or an inductor. Assume the capacitor has a large capacitance and the inductor has a large inductance but no resistance. The light bulb has high efficiency, glowing whenever it carries electric current. (i) Describe what the light bulb does in each of circuits (a) through (d) after the switch is thrown closed. (ii) Describe what the light bulb does in each of circuits (a) through (d) when, having been closed for a long time interval, the switch is opened.



Single Correct Answer Type

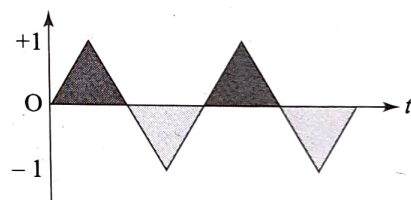
2. A coil of Cu wire (radius- r , self-inductance- L) is bent in two concentric turns each having radius $\frac{r}{2}$. The self-inductance is now
 (a) $2L$ (b) L
 (c) $4L$ (d) $L/2$
3. If in a coil rate of change of area is $\frac{5 \text{ metre}^2}{\text{milli second}}$ and current become 1 amp from 2 amp in 2×10^{-3} sec. If magnetic field is 1 Tesla, then self-inductance of the coil is
 (a) 2 H (b) 5 H
 (c) 20 H (d) 10 H

4. The current through a 4.6 H inductor is shown in the following graph. The induced emf during the time interval $t = 5$ millisecc to 6 millisecc will be



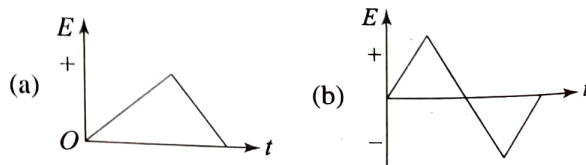
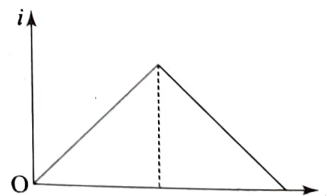
- (a) 10^3 V (b) -23×10^3 V
 (c) 23×10^3 V (d) Zero

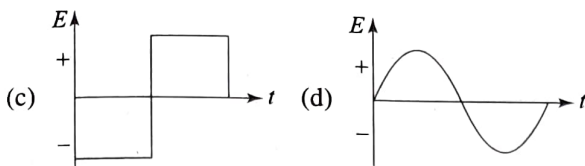
5. An alternating current of frequency 200 rad/sec and peak value 1 A as shown in the figure is applied to the primary of a transformer. If the coefficient of mutual induction between the primary and the secondary is 1.5 H, the voltage induced in the secondary will be



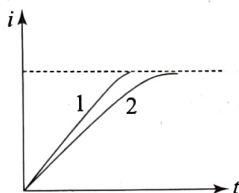
- (a) 300 V (b) 191 V
 (c) 220 V (d) 471 V

6. The current i in an inductance coil varies with time, t according to the graph shown in the figure. Which one of the following plots shows the variation of voltage in the coil with time?



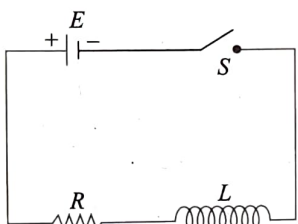


7. When a certain circuit consisting of a constant e.m.f. E an inductance L and a resistance R is closed, the current in it increases with time according to curve 1. After one parameter (E , L or R) is changed, the increase in current follows curve 2 when the circuit is closed second time. Which parameter was changed and in what direction?

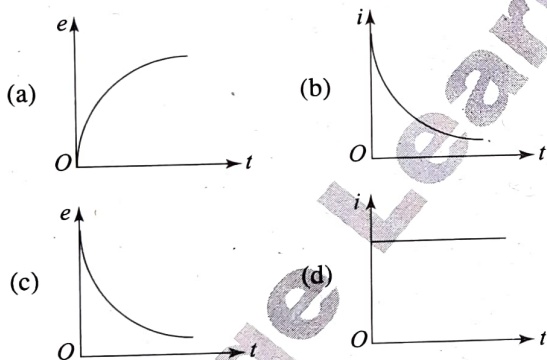


- (a) L is increased
(b) L is decreased
(c) R is increased
(d) R is decreased

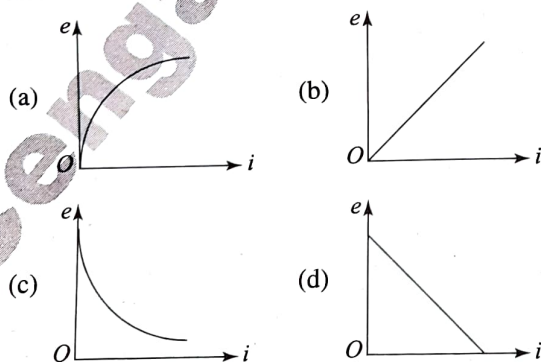
8. Switch S of the circuit shown in the figure is closed at $t = 0$.



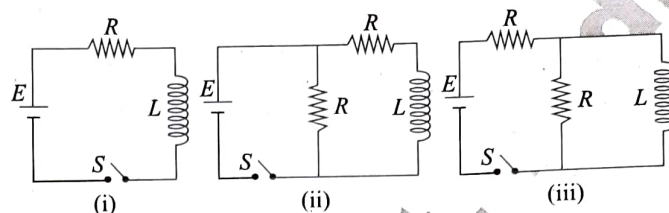
If e denotes the induced emf in L and i , the current flowing through the circuit at time t , which of the following graphs is correct.



9. For previous objective, which of the following graphs is correct

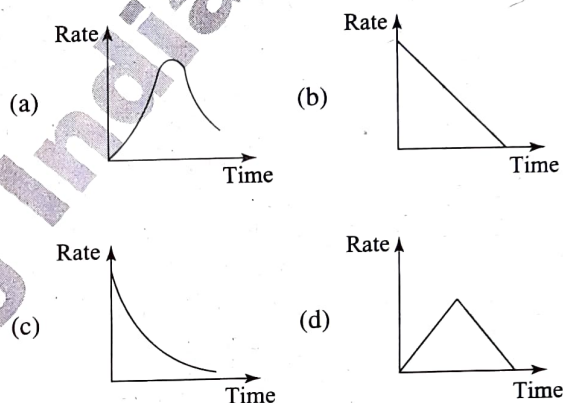


10. In which of the following circuit is the current maximum just after the switch S is closed

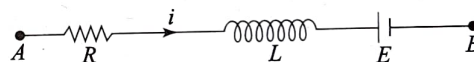


- (a) (i) (b) (ii)
(c) (iii) (d) Both (ii) and (iii)

11. In an L - R circuit connected to a battery the rate at which energy is stored in the inductor is plotted against time during the growth of the current in the circuit. Which of the following best represents the resulting curve?

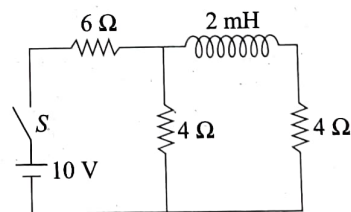


12. In the circuit diagram shown, $R = 10 \Omega$, $L = 5 \text{ mH}$, $E = 10 \text{ V}$ and $i = 1 \text{ A}$. The current is decreasing at the rate of 10^3 A/S . Then $(V_A - V_B)$ at this instant is:



- (a) 10 V (b) 15 V
(c) 20 V (d) 25 V

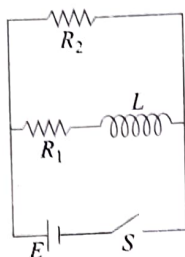
13. In the given circuit, let i_1 be the current drawn from battery at time $t = 0$ and i_2 be steady current at $t = \infty$, then the ratio $\frac{i_1}{i_2}$ is



- (a) 1.0 (b) 0.8
(c) 1.2 (d) 1.5

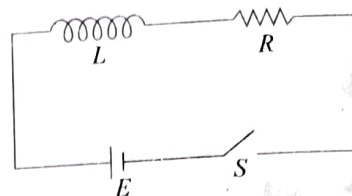
4.6 Magnetism and Electromagnetic Induction

14. Consider the circuit shown in the figure. The current through the battery a long time after the switch S is closed is:



- (a) $\frac{E}{R_1}$ (b) $\frac{E}{R_2}$
 (c) $\frac{E}{R_1 + R_2}$ (d) $\frac{E(R_1 + R_2)}{R_1 R_2}$

15. In the circuit shown, switch S is closed at time $t = 0$. The charge which passes through the battery in one time constant is



- (a) $\frac{eR^2 E}{L}$ (b) $E \left(\frac{L}{R} \right)$
 (c) $\frac{EL}{eR^2}$ (d) $\frac{eL}{ER}$

Answers Key

Single Correct Answer Type

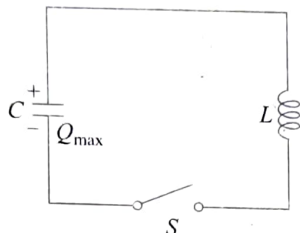
2. (a) 3. (d) 4. (c) 5. (b) 6. (c) 7. (a) 8. (c) 9. (d) 10. (b) 11. (a)
 12. (b) 13. (b) 14. (d) 15. (c)

DPP 4.3

R-L and L-C Circuits

Concept Based

1. After the switch is closed in the LC circuit shown in the figure, the charge on the capacitor is sometimes zero, but at such instants the current in the circuit is not zero. How is this behavior possible?



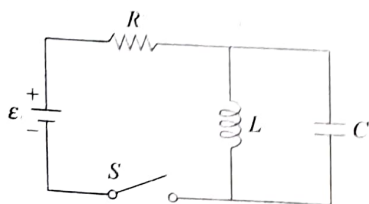
2. Discuss the similarities between the energy stored in the electric field of a charged capacitor and the energy stored in the magnetic field of a current-carrying coil.

Subjective Type

3. A flat coil of wire has an inductance of 40.0 mH and a resistance of 5.00 Ω . It is connected to a 22.0-V battery at the instant $t = 0$. Consider the moment when the current is 3.00 A. (a) At what rate is energy being delivered by the battery? (b) What is the power being delivered to the resistance of the coil? (c) At what rate is energy being stored in the magnetic field of the coil? (d) What is the relationship among these three power values? (e) Is the relationship described in part (d) true at other instants as well? (f) Explain the relationship at the moment immediately after $t = 0$ and at a moment several seconds later.

Single Correct Answer Type

4. In the circuit of figure, the battery emf is ϵ the resistance is R and the capacitance is C . The switch S is closed for a long time interval, and zero potential difference is measured across the capacitor.



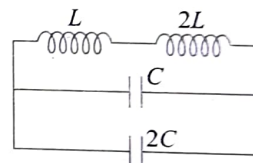
After the switch is opened, the potential difference across the capacitor reaches a maximum value of ΔV . What is the value of the inductance?

- (a) $\frac{C(\Delta V)^2}{2\epsilon^2}$ (b) $\frac{C(\Delta V)^2}{\epsilon^2}$
 (c) $\frac{2C(\Delta V)^2}{\epsilon^2}$ (d) $\frac{C(\Delta V)^2}{4\epsilon^2}$

5. A 1.00 μF capacitor is charged by a 40.0 V power supply. The fully charged capacitor is then discharged through a 10.0 mH inductor. Find the maximum current in the resulting oscillations.

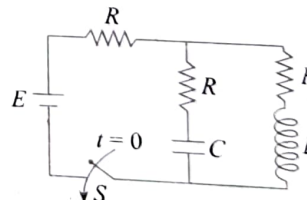
- (a) 400 mA (b) 800 mA
 (c) 600 mA (d) 150 mA

6. The frequency of oscillation of current in the inductor is:



- (a) $\frac{1}{3\sqrt{LC}}$ (b) $\frac{1}{6\pi\sqrt{LC}}$
 (c) $\frac{1}{\sqrt{LC}}$ (d) $\frac{1}{2\pi\sqrt{LC}}$

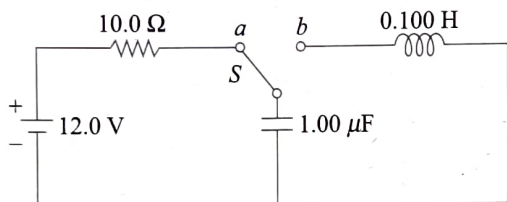
7. In the circuit shown in the figure, L is ideal inductor and E is ideal cell. Switch S is closed at $t = 0$. Then:



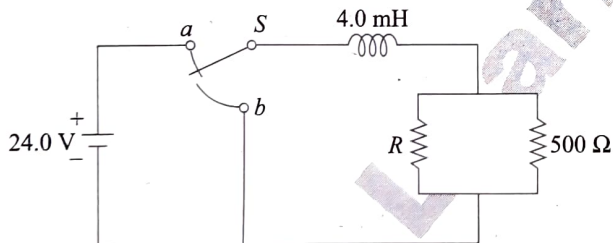
- (a) after a long time interval potential difference across capacitor and inductor will be equal.
 (b) after a long time interval charge on capacitor will be EC .
 (c) after a long time interval current in the inductor will be E/R .
 (d) after a long time interval current through battery will be less than current through it initially.

Multiple Correct Answers Type

8. A 100 V battery, a 5.00 V resistor, and a 10.0 H inductor are connected in series. After the current in the circuit has reached its maximum value,
- the power being supplied by the battery is 20.0 W
 - the power being delivered to the resistor is 20.0 W
 - the power being delivered to the inductor zero
 - the energy stored in the magnetic field of the inductor is 20.0 J
9. The switch in figure is connected to position a for a long time interval. At $t = 0$ the switch is thrown to position b. After this time, what are
- the frequency of oscillation of the LC circuit is 200 Hz
 - the maximum charge that appears on the capacitor is 12 μC
 - the maximum current in the inductor is 38 mA (approx.)
 - the total energy the circuit possesses at $t = 3.00$ s is 72 μJ

**Comprehension Type****For Q. 10 and 11**

Consider the circuit shown in figure.



10. When the switch is in position a, for what value of R will the circuit have a time constant of 10 μs ?
- 2.0 $\text{k}\Omega$
 - 2.5 $\text{k}\Omega$
 - 1.0 $\text{k}\Omega$
 - none of these

11. What is the current in the inductor at the instant the switch is thrown to position b?
- 30 mA
 - 60 mA
 - 10 mA
 - none of these

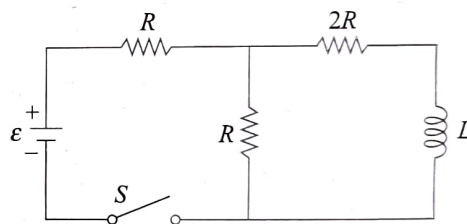
For Q. 12 and 13

A circuit consists of a coil, a switch, and a battery, all in series. The internal resistance of the battery is negligible compared with that of the coil. The switch is originally open. It is thrown closed, and after a time interval Δt , the current in the circuit reaches 80.0% of its final value. The switch then remains closed for a time interval much longer than Δt . The wires connected to the terminals of the battery are then short circuited with another wire and removed from the battery, so that the current is uninterrupted.

12. At an instant that is a time interval Δt . After the short circuit, the current is what percentage of its maximum value?
- 20.0%
 - 8.0%
 - 4.0%
 - 10.0%
13. At the moment $2\Delta t$ after the coil is short-circuited, the current in the coil is what percentage of its maximum value?
- 20.0%
 - 8.0%
 - 4.0%
 - 10.0%

For Q. 14 and 15

The switch in the figure is open for $t < 0$ and is then thrown closed at time $t = 0$. Assume $R = 4.00 \Omega$, $L = 1.00$ H, and $\mathcal{E} = 10.0$ V.



14. The current in the inductor as functions of time
- (0.5 A) $[1 - e^{-20t/s}]$
 - (0.5 A) $[1 - e^{-10t/s}]$
 - (2.5 A) $[1 - e^{-10t/s}]$
 - (0.5 A) $[1 - e^{-15t/s}]$
15. The current in the switch as functions of time t .
- 2.5 A $-(0.25 \text{ A})e^{-10t/s}$
 - 1.5 A $-(0.5 \text{ A})e^{-10t/s}$
 - 2.5 A $-(0.5 \text{ A})e^{-10t/s}$
 - 1.5 A $-(0.25 \text{ A})e^{-10t/s}$

Answers Key**Subjective Type**

3. (a) 66 W (b) 45 W (c) 21 W (e) yes

Single Correct Answer Type

4. (b) 5. (a) 6. (b) 7. (d)

Multiple Correct Answers Type

8. (a, b, c, d) 9. (b, c, d)

Comprehension Type

10. (a) 11. (b) 12. (a) 13. (c) 14. (b)
15. (d)

Alternating Current

DPP 5.1

Average Value and Root Mean Square Value in AC

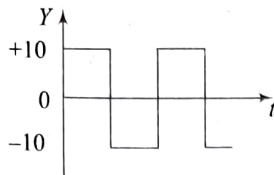
Single Correct Answer Type

- A generator produces a voltage that is given by $V = 240 \sin 120 t$, where t is in seconds. The frequency and r.m.s. voltage are
 (a) 60 Hz and 240 V (b) 19 Hz and 120 V
 (c) 19 Hz and 170 V (d) 754 Hz and 70 V
- The peak value of an alternating e.m.f. E is given by $E = E_0 \cos \omega t$ is 10 V and its frequency is 50 Hz. At time $t = \frac{1}{600}$ s, the instantaneous e.m.f. is
 (a) 10 V (b) $5\sqrt{3}$ V (c) 5 V (d) 1 V
- A resistance of 20 ohms is connected to a source of an alternating potential $V = 220 \sin (100 \pi t)$. The time taken by the current to change from its peak value to r.m.s. value is
 (a) 0.2 sec (b) 0.25 sec
 (c) 25×10^{-3} sec (d) 2.5×10^{-3} sec
- Voltage and current in an ac circuit are given by $V = 5 \sin \left(100 \pi t - \frac{\pi}{6} \right)$ and $I = 4 \sin \left(100 \pi t + \frac{\pi}{6} \right)$
 (a) Voltage leads the current by 30°
 (b) Current leads the voltage by 30°
 (c) Current leads the voltage by 60°
 (d) Voltage leads the current by 60°
- In a certain circuit current changes with time according to $i = 2\sqrt{t}$. r.m.s. value of current between $t = 2$ to $t = 4$ s will be
 (a) 3 A (b) $3\sqrt{3}$ A
 (c) $2\sqrt{3}$ A (d) $(2 - \sqrt{2})$ A
- Match the following

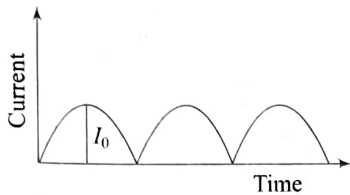
Currents	r.m.s. values
(1) $x_0 \sin \omega t$	(i) x_0
(2) $x_0 \sin \omega t \cos \omega t$	(ii) $\frac{x_0}{\sqrt{2}}$
(3) $x_0 \sin \omega t + x_0 \cos \omega t$	(iii) $\frac{x_0}{(2\sqrt{2})}$

 (a) 1. (i), 2. (ii), 3. (iii) (b) 1. (ii), 2. (iii), 3. (i)
 (c) 1. (i), 2. (iii), 3. (ii) (d) None of these
- If $t = t^2$ $0 < t < T$, then r.m.s. value of current is
 (a) $\frac{T^2}{\sqrt{2}}$ (b) $\frac{T^2}{2}$
 (c) $\frac{T^2}{\sqrt{5}}$ (d) None of these
- The r.m.s. voltage of the wave form shown is
 (a) 10 V (b) 7 V
 (c) 6.37 V (d) None of these

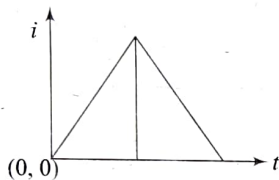
5.2 Magnetism and Electromagnetic Induction



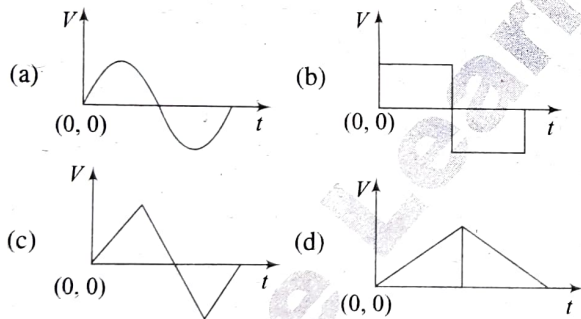
9. The output current versus time curve of a rectifier is shown in the figure. The average value of output current in this case is



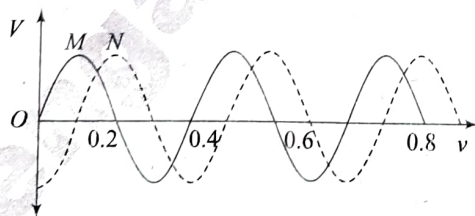
- (a) 0
(b) $\frac{I_0}{2}$
(c) $\frac{2I_0}{\pi}$
(d) I_0
10. The current ' i ' in an inductance coil varies with time ' t ' according to following graph:



Which one of the following plots shows the variations of voltage in the coil?



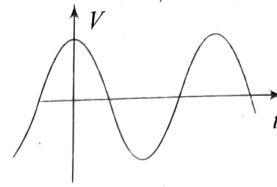
11. Two sinusoidal voltages of the same frequency are shown in the diagram. What is the frequency, and the phase relationship between the voltages?



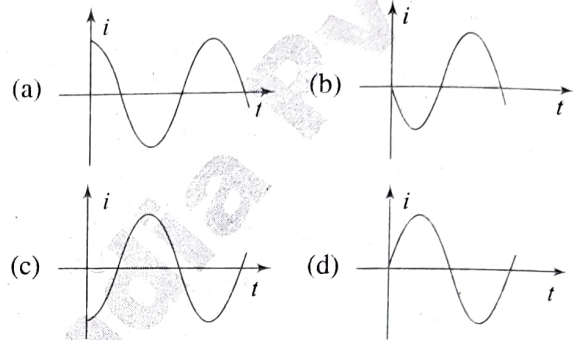
Frequency in Hz Phase lead of N over M in radians

- (a) 0.4 $-\pi/4$
(b) 2.5 $-\pi/2$
(c) 2.5 $+\pi/2$
(d) 2.5 $-\pi/4$

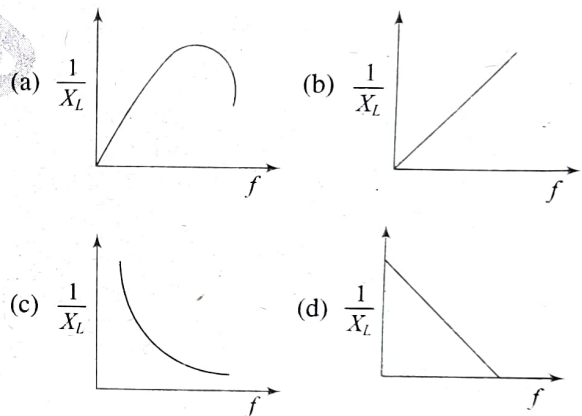
12. The voltage across a pure inductor is represented by the following diagram.



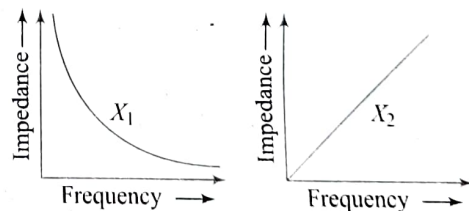
Which one of the following diagrams will represent the current?



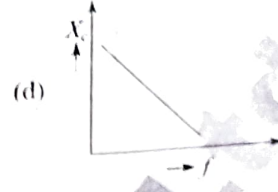
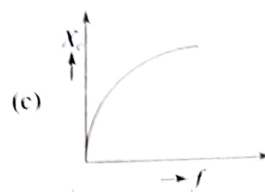
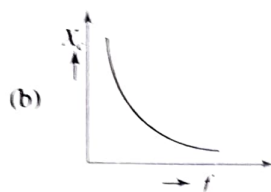
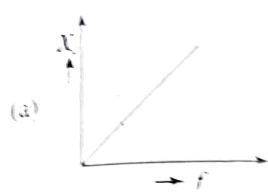
13. In pure inductive circuit, the curves between frequency f and reciprocal of inductive reactance $1/X_L$ is



14. The graphs given below depict the dependence of two reactive impedances X_1 and X_2 on the frequency of the alternating e.m.f. applied individually to them. We can then say that



- (a) X_1 is an inductor and X_2 is a capacitor
(b) X_1 is a resistor and X_2 is a capacitor
(c) X_1 is a capacitor and X_2 is an inductor
(d) X_1 is an inductor and X_2 is a resistor
15. Which of the following curves correctly represents the variation of capacitive reactance X_C with frequency f



Answers Key

Single Correct Answer Type

1. (c) 2. (b) 3. (d) 4. (c) 5. (c)

6. (b) 7. (c) 8. (a) 9. (c) 10. (b)
11. (b) 12. (d) 13. (c) 14. (c) 15. (b)

DPP 5.2

Alternating Circuits

Single Correct Answer Type

1. Is the following circuit correctly drawn?

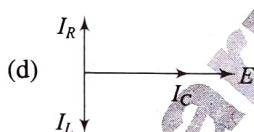
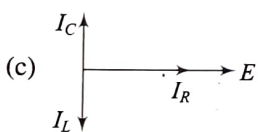
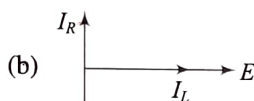
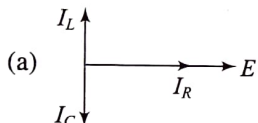
(a) Yes

(b) No

(c) Cannot be predicted

(d) Insufficient data to reply

2. An alternating emf is applied across a parallel combination of a resistance R , capacitance C and an inductance L . If I_R , I_L , I_C are the currents through R , L and C respectively, then the diagram which correctly represents the phase relationship among I_R , I_L , I_C and source emf E , is given by



3. When 100 V dc is supplied across a solenoid, a current of 1.0 A flows in it. When 100 V ac is applied across the same coil, the current drops to 0.5 A. If the frequency of ac source is 50 Hz, then the impedance and inductance of the solenoid are

(a) 200 Ω and 0.55 H (b) 100 Ω and 0.86 H

(c) 200 Ω and 1.0 H (d) 100 Ω and 0.93 H

4. A bulb and a capacitor are in series with an ac source. On increasing frequency how will glow of the bulb change?

(a) The glow decreases

(b) The glow increases

(c) The glow remain the same

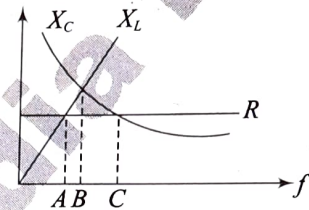
(d) Bulb quenches

5. For a series RLC circuit $R = X_L = 2X_C$. The impedance of the circuit and phase difference (between) V and i will be

(a) $\frac{\sqrt{5}R}{2}$, $\tan^{-1}(2)$ (b) $\frac{\sqrt{5}R}{2}$, $\tan^{-1}\left(\frac{1}{2}\right)$

(c) $\sqrt{5}X_C$, $\tan^{-1}(2)$ (d) $\sqrt{5}R$, $\tan^{-1}\left(\frac{1}{2}\right)$

6. The figure shows variation of R , X_L and X_C with frequency f in a series L, C, R circuit. Then for what frequency point, the circuit is inductive?



(a) A

(b) B

(c) C

(d) All points

7. Same current is flowing in two alternating circuits. The first circuit contains only inductance and the other contains only a capacitor. If the frequency of the e.m.f. of ac is increased, the effect on the value of the current will be

(a) increased in the first circuit and decreased in the other

(b) increased in both the circuits

(c) decreased in both the circuits

(d) decreased in the first circuit and increased in the other

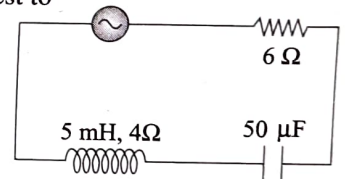
8. In the circuit shown below, the ac source has voltage $V = 20 \cos(\omega t)$ volts with $\omega = 2000$ rad/s. The amplitude of the current will be nearest to

(a) 2 A

(b) 3.3 A

(c) $2/\sqrt{5}$ A

(d) $\sqrt{5}$ A



9. In an LCR circuit, $R = 100 \Omega$. When capacitance C is removed, the current lags behind the voltage by $\pi/3$. When inductance L is removed, the current leads the voltage by $\pi/3$. The impedance of the circuit is

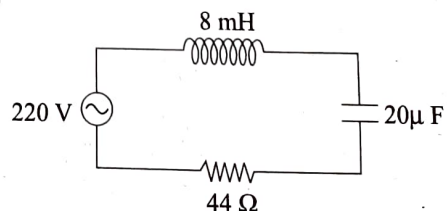
(a) 50 Ω

(b) 100 Ω

(c) 200 Ω

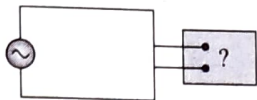
(d) 400 Ω

10. For the series LCR circuit shown in the figure, what is the resonance frequency and the amplitude of the current at the resonating frequency?



- (a) 2500 rad s^{-1} and $5\sqrt{2} \text{ A}$
 (b) 2500 rad s^{-1} and 5 A
 (c) 2500 rad s^{-1} and $\frac{5}{\sqrt{2}} \text{ A}$
 (d) 2500 rad s^{-1} and $5\sqrt{2} \text{ A}$

11. Following figure shows an ac generator connected to a "block box" through a pair of terminals. The box contains possible R , L , C or their combination, whose elements and arrangements are not known to us. Measurements outside the box reveals that



$e = 75 \sin(\sin \omega t)$ volt, $i = 1.5 \sin(\omega t + 45^\circ)$ amp, then the wrong statement is

- (a) There must be a capacitor in the box.
 (b) There must be an inductor in the box.
 (c) There must be a resistance in the box.
 (d) The power factor is 0.707.
12. A resistor R , an inductor L and a capacitor C are connected in series to an oscillator of frequency n . If the resonant frequency is n_r , then the current lags behind voltage, when

- (a) $n = 0$
 (b) $n < n_r$
 (c) $n = n_r$
 (d) $n > n_r$

Comprehension Based

In a series L - R circuit, connected with a sinusoidal ac source, the maximum potential difference across L and R are, respectively, 3 V and 4 V.

13. At an instant the potential difference across resistor is 2 volts. The potential difference in volt across the inductor at the same instant will be
 (a) $3 \cos 30^\circ$ (b) $3 \cos 60^\circ$
 (c) $6 \cos 45^\circ$ (d) 6
14. At the same instant, the magnitude of the potential difference in volt across the ac source will be
 (a) $3 \cos 67^\circ$ (b) $5 \cos 83^\circ$
 (c) $6 \cos 97^\circ$ (d) 0
15. If the current at this instant is decreasing the magnitude of potential difference at that instant across the ac source is
 (a) Increasing (b) Decreasing
 (c) Constant (d) Cannot be said

Answers Key

Single Correct Answer Type

1. (a) 2. (c) 3. (a) 4. (b) 5. (b)
 6. (c) 7. (d) 8. (a) 9. (b) 10. (b)
 11. (b) 12. (d)

Comprehension Type

13. (a) 14. (b) 15. (a)

DPP 5.3

Alternating Circuits and Power in AC

Single Correct Answer Type

1. The r.m.s. current in an ac circuit is 2 A. If the wattless current be $\sqrt{3}$ A, what is the power factor?

(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{1}{\sqrt{2}}$
(c) $\frac{1}{2}$ (d) $\frac{1}{3}$

2. $\frac{2.5}{\pi}$ μF capacitor and 3000Ω resistance are joined in series to an ac source of 200 V and 50 sec^{-1} frequency. The power factor of the circuit and the power dissipated in it will be, respectively,

(a) 0.6, 0.06 W (b) 0.06, 0.6 W
(c) 0.6, 4.8 W (d) 4.8, 0.6 W

3. The self-inductance of a choke coil is 10 mH. When it is connected with a 10 V dc source, then the loss of power is 20 W. When it is connected with 10 V ac source loss of power is 10 W. The frequency of ac source will be

(a) 50 Hz (b) 60 Hz
(c) 80 Hz (d) 100 Hz

4. A group of electric lamps having a total power rating of 1000 W is supplied by an ac voltage $E = 200 \sin(310t + 60^\circ)$. Then the r.m.s. value of the circuit current is

(a) 10 A (b) $10\sqrt{2}$ A
(c) 20 A (d) $20\sqrt{2}$ A

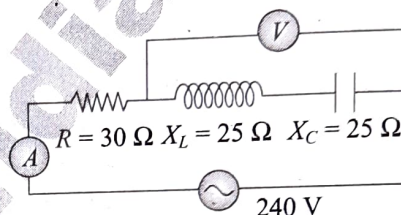
5. In an LR-circuit, the inductive reactance is equal to the resistance R of the circuit. An e.m.f. $E = E_0$ applied to the circuit. The power consumed in the circuit is

(a) $\frac{E_0^2}{R}$ (b) $\frac{E_0^2}{2R}$
(c) $\frac{E_0^2}{4R}$ (d) $\frac{E_0^2}{8R}$

6. An LCR series circuit with a resistance of 100 ohm is connected to an ac source of 200 V (r.m.s.) and angular frequency 300 rad/s. When only the capacitor is removed, the current lags behind the voltage by 60° . When only the inductor is removed the current leads the voltage by 60° . The average power dissipated is

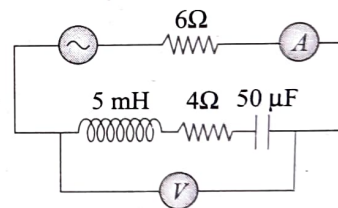
(a) 50 W (b) 100 W
(c) 200 W (d) 400 W

7. In the circuit shown in figure neglecting source resistance the voltmeter and ammeter reading will respectively, will be



(a) 0 V, 3 A (b) 150 V, 3 A
(c) 150 V, 6 A (d) 0 V, 8 A

8. In the circuit shown in the figure, the ac source gives a voltage $V = 20 \cos(2000t)$. Neglecting source resistance, the voltmeter and ammeter reading will be

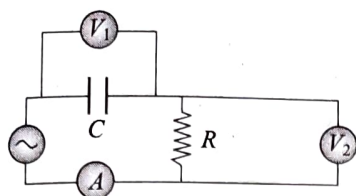


(a) 0 V, 0.47 A (b) 1.68 V, 0.47 A
(c) 0 V, 1.4 A (d) 5.6 V, 1.4 A

9. An ac source of angular frequency ω is fed across a resistor r and a capacitor C in series. The current registered is I . If now the frequency of source is changed to $\omega/3$ (but maintaining the same voltage), the current in then circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency ω

(a) $\sqrt{\frac{3}{5}}$ (b) $\sqrt{\frac{2}{5}}$
(c) $\sqrt{\frac{1}{5}}$ (d) $\sqrt{\frac{4}{5}}$

10. The diagram shows a capacitor C and a resistor R connected in series to an ac source. V_1 and V_2 are voltmeters and A is an ammeter



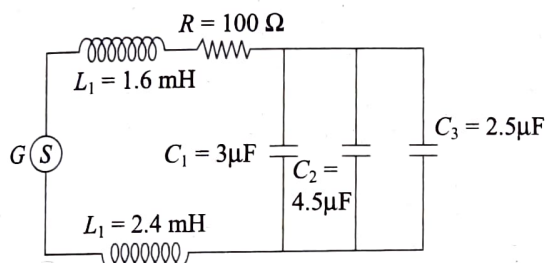
Consider now the following statements

- I. Readings in A and V_2 are always in phase
- II. Reading in V_1 is ahead in phase with reading in V_2
- III. Readings in A and V_1 are always in phase which of these statements are/is correct

- (a) I only
- (b) II only
- (c) I and II only
- (d) II and III only

Comprehension Based

An ac generator G with an adjustable frequency of oscillation is used in the circuit, as shown.



11. Current drawn from the ac source will be maximum if its angular frequency is
 - (a) 10^5 rad/s
 - (b) 10^4 rad/s
 - (c) 5000 rad/s
 - (d) 500 rad/s
12. To increase resonant frequency of the circuit, some of the changes in the circuit are carried out. Which change(s) would certainly result in the increase in resonant frequency?
 - (a) R is increased.
 - (b) L_1 is increased and C_1 is decreased.
 - (c) L_2 is decreased and C_2 is increased.
 - (d) C_3 is removed from the circuit.
13. If the ac source G is of 100 V rating at resonant frequency of the circuit, then average power supplied by the source is
 - (a) 50 W
 - (b) 100 W
 - (c) 500 W
 - (d) 1000 W
14. Average energy stored by the inductor L_2 (Source is at resonance frequency) is equal to
 - (a) zero
 - (b) 1.2 mJ
 - (c) 2.4 mJ
 - (d) 4 mJ
15. Thermal energy produced by the resistance R in time duration 1 ms, using the source at resonant condition, is
 - (a) 0 J
 - (b) 1 μJ
 - (c) 100 μJ
 - (d) not possible to calculate from the given information

Answers Key

Single Correct Answer Type

1. (c)
2. (c)
3. (c)
4. (b)
5. (c)
6. (d)
7. (d)
8. (d)
9. (a)
10. (b)

Comprehension Type

11. (c)
12. (d)
13. (b)
14. (b)
15. (d)